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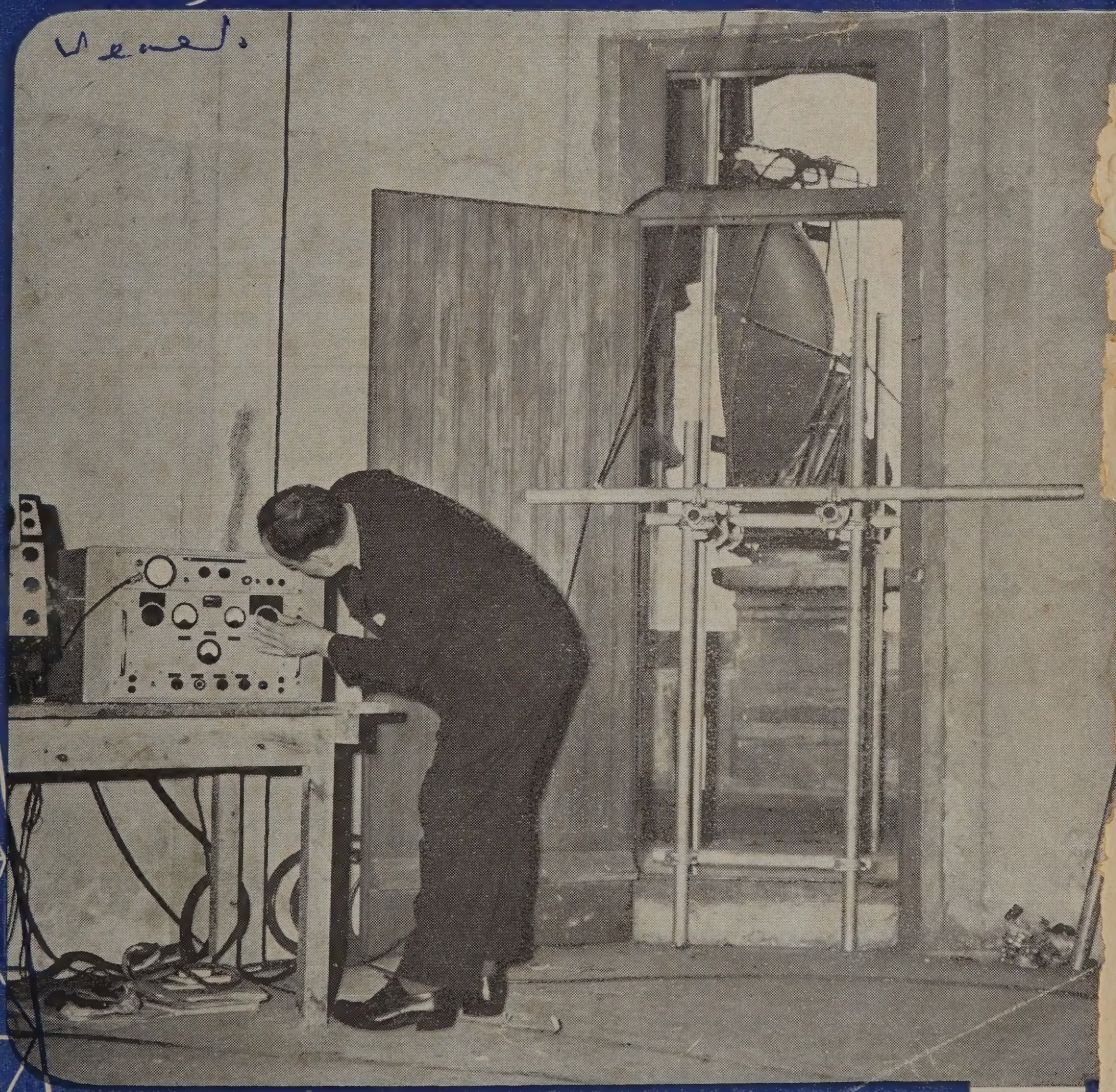

MAY, 1st, 1953 VOL. 8, NO. 3

1/10

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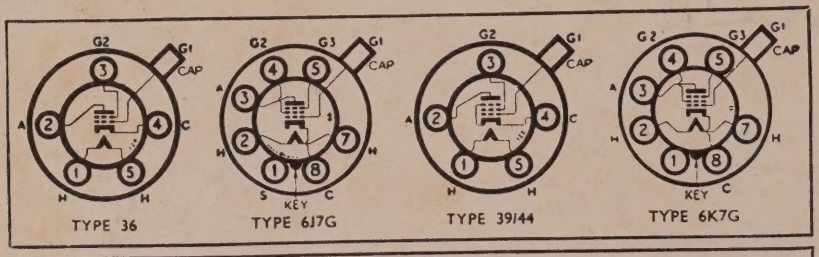
Types 36 and 39/44 were widely used in Philco and other American type receivers dated 1933-1936. Replacement by Brimar types 6J7G and 6K7G respectively, involves a change of sockets and re-alignment of receiver. The substitution of the new valves will give increased gain and it may be necessary to reduce screen voltages or re-arrange wiring to preserve stability.



TYPE	CHANGE SOCKET		CHANGE CONNECTIONS		OTHER WORK NECESSARY	PERFORMANCE CHANGE
	FROM	TO	FROM OLD SOCKET	TO NEW SOCKET		
6J7G	U.X. 5-pin.	OCTAL	Pin No. 1 2 3	Pin No. 2 3 4 8 7	Connect Pins 1 & 5 to Pin No. 8. Change top cap connector. Re-align receiver. See *note*.	SLIGHTLY HIGHER GAIN.
6K7G	U.X. 5 pin.	OCTAL	Pin No. 1 2 3 4 5	Pin No. 2 3 4 8 7	Connect Pin 5 to Pin 8. Change top cap connector. Re-align receiver.	SLIGHTLY HIGHER GAIN.

Note: A higher value of screen dropping resistor (to Pin 4 of Type 6J7G) may be necessary to ensure that the screen voltage does not exceed 100 volts.

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A Transistor Age?

In all branches of technology there arrive from time to time developments which cause major upheavals in established techniques. One of the most notable of these was the way in which the vacuum tube revolutionized, almost overnight, the accepted method of "wireless signalling," or radio transmission and reception, as it is more commonly known today. And with the advent of the valve, there came the germ of what we now call "electronics." How rapidly that germ has propagated itself is now common knowledge, added to which it shows no signs of diminishing fertility. Indeed, the reverse is the case, owing not only to such logical and foreseeable developments as the world-wide spread of television, but also to such things as the rise of the transistor.

This latter device, of insignificant physical proportions, bids fair to cause yet another revolution in the radio and electronic territories. It is a remarkably small and simple thing, and its power requirements are much smaller than those of even the smallest sub-miniature valves of conventional type. Unfortunately, it can not yet be said to be out of the development stage. Several large laboratories, both in the United States and in England, are working at high pressure on perfecting them to the stage where they can become mass-produced and therefore reliable and inexpensive enough to allow their use in commercial equipment. Very great strides have been made in a very short time already, and sufficient exploration has been done of their possibilities to encourage those engaged in the development work to proceed apace. It thus behoves us to examine the position and see what the transistor may have in store for the electronics industry.

Already, the R.C.A. in America has produced several laboratory curiosities designed to point the way to the future application of transistors. The most spectacular of these was the portable television receiver, which contained no vacuum tubes other than the cathode ray viewing tube. This, in the words of the famous, "makes yer think." Any built-up equipment using transistors does away entirely with heated cathodes. This represents a considerable saving of power from the primary source, whether it be an A.C. power pack or a set of dry batteries. Not only this, but all the heat that normally has to be dissipated from the heater windings of conventional valves no longer has to be conducted away. As a direct result, the equipment will run considerably cooler, and this will make for better operating conditions for small parts such as resistors and condensers, which will not have to work in high ambient temperatures. Resistors, for example, will be called upon to dissipate their own heat, while condensers will not have to work in an atmosphere many degrees warmer than room temperature, with beneficial effects on their insulation resistance and many other important properties. It will be possible to make radio receivers considerably smaller than they now are, and such things as wrist-watch radios will be a commonplace, should there be sufficient demand for them. Hearing aids will shrink to even smaller dimensions than they have at present. Television receivers will benefit, too. When transistors are cheap enough, they will result in substantial decreases in the size and cost of television receivers. They should be considerably more reliable than conventional tubes, and this will be a major consideration in furthering the use of electronic equipment in industry, where, even today, the electron tube is looked upon with somewhat of a jaundiced eye because of its fallibility.

One could go on amplifying the above list indefinitely, but it would serve little purpose. There seems little doubt that ultimately transistors will take over completely many functions now performed by valves, although it is inconceivable that the vacuum tube should be completely ousted from the field. How soon it will be before the transistor makes substantial practical inroads into the domain of the valve is anybody's guess. For one thing, manufacturers admit that they do not yet know how to make them. That is to say, although successful transistors can certainly be made, the day has not yet come when large batches of them can be produced easily and quickly, with anything approaching the uniformity of characteristics which typifies the modern radio valve. It is significant, however, that various makers in the U.S.A. have announced that limited quantities can now be made available to development laboratories and others for experimental work, and that the chairman of R.C.A. considers transistors to be one of the most significant developments of our time, and certainly *the* most important of this decade.

Already in the technical press, articles are appearing describing such technical stunts as transistor receivers, using a three-volt dry battery as the sole source of power and capable of driving a small loudspeaker. Such things certainly form the shadow of things to come, and everyone technically interested in radio should lose no time in acquainting himself with the peculiarities of these new things. Although they amplify, in a way loosely analagous to the amplification of ordinary valves, their techniques will certainly be very different, and we will need to have a whole new armoury of circuitry for them. Our thinking about oscillators, amplifiers, etc., will have to be drastically modified in order to fit what will really be a new medium. This rather underlines the thought that technical progress, while never static, has never been less so than at the present time. By implication, then, it behoves us to move with the times.

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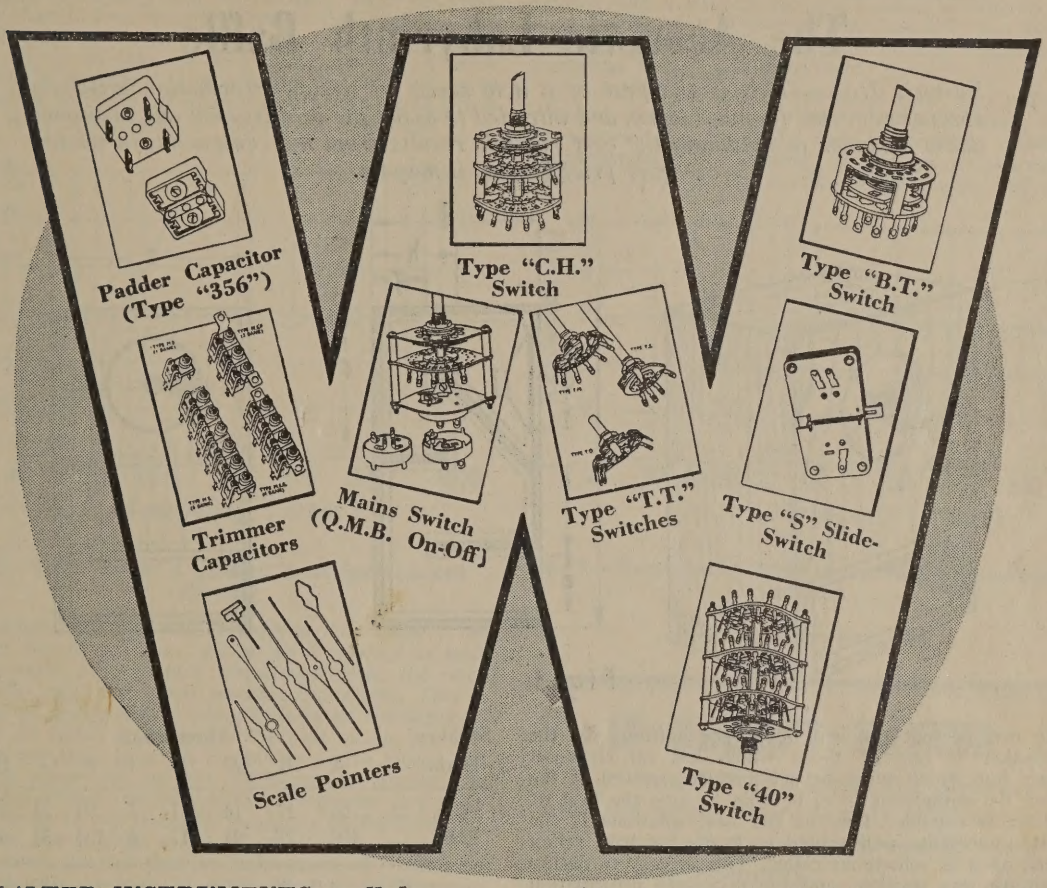

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Audiofacts

The Acoustic Labyrinth Baffle

Editor's Note.—This is the first of a new series of design-information articles, specially devoted to audio work, and intended to assist the professional and amateur audio designer in obtaining the best possible results from his equipment, in whatever price bracket it may lie.

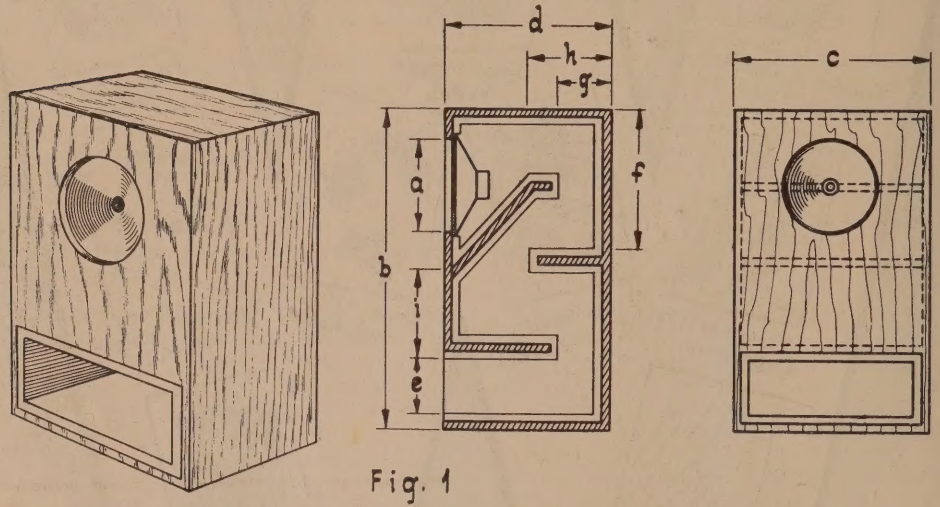

Fig. 1

The ever-present problem of proper baffling for the loudspeaker is one of those which has no clear-cut answer, but which must be satisfactorily solved if the rest of the equipment is to be able to give the best of which it is capable. One of the best solutions is the almost universally used vented enclosure, or bass reflex cabinet, as it is sometimes called. This is easy to design for almost any speaker, and the necessary information has been printed in this journal before. However, the bass reflex is not the only satisfactory baffle by any means. The acoustic labyrinth, described here, is a little more trouble to make, but has the advantage of providing adequate baffling for a given speaker in the smallest possible space, as it takes up slightly less room than the bass reflex.

PRINCIPLE OF OPERATION

The manner in which the labyrinth operates is not so very different from that of the bass reflex. In both, the acoustic properties of a specially designed enclosure are used to reduce the adverse effects of the bass resonance of the speaker unit itself, and in both, the sound from the back of the cone is led out to the front and is utilized as well as the sound that comes directly off the front of the cone. In both baffles, the action relies for its effect on the resonant properties of a volume of air. In the bass reflex, the volume of air in the box is made to resonate at the same frequency as the cone of the speaker. This air is coupled acoustically to the diaphragm of the speaker in such a way that the two resonant systems act in very much the same way as a pair of coupled tuned circuits in an I.F. transformer. It is well known that in the latter, both circuits are tuned to the same frequency, and that if they are more tightly coupled than a certain critical amount, the frequency

Speaker Diam.	Dimensions A	B	C	D	E	F	G	H	I
8 in.	6½	17	14	11½	3	9½	2½	5	3¾
12 in.	10½	28	21	17	6	13½	5¾	6[	5

Note.—All dimensions in the above table are in inches.

response curve of the transformer exhibits not just one peak, but two, side by side, and of lower amplitude than the single peak which occurs when the coupling is less than the critical amount. In radio receivers we make use of this effect to broaden the response of the set. In the case of the bass reflex baffle, the speaker cone and the air in the box represent the primary and secondary of the I.F. transformer, and the vent is the means by which they are coupled together. This coupling, just as in the over-coupled transformer, is great enough for the two-peak effect to come into play, and in this case, there are two beneficial effects on the performance of the speaker. In the first place, the resonant peak caused by the speaker cone is very greatly reduced in amplitude, and secondly, the over-coupling effect produces a twin-peaked response curve, in which the two peaks are spaced one above, and one below the frequency of the original speaker peak. This effectively extends the useful response of the speaker to lower frequencies than it will handle in a conventional flat or open-backed baffle. The behaviour just described is illustrated in Fig. 2, in which the dotted curve shows the response of the speaker in a flat baffle of large dimensions, and the full curve, the response of the same speaker in a properly-designed bass reflex cabinet.

The main difference between the bass reflex and the labyrinth is that the latter reduces the resonant peak of the speaker by loading it at the resonant frequency, more heavily than it does at other frequencies. The labyrinth is really nothing more than a long pipe, conveniently folded so as to take up less space than if it were straight. It has very close affinities to both an organ pipe and to an electrical transmission line, both of which can be used as analogies to explain its behaviour.

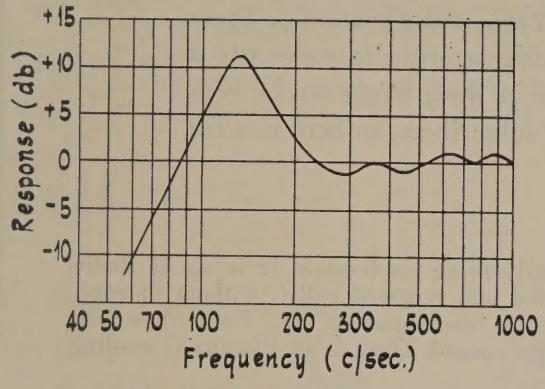

Fig. 2.—Response of a speaker in an open-backed cabinet.

In the labyrinth, the most important dimension is the length of the folded tube. When the frequency is such that the tube is a quarter wavelength long, the open end of the tube has a low acoustic impedance. This is the same as saying that it offers little or no resistance to the flow of sound waves from the pipe to the air outside. At the same time, its impedance at the closed end (which is where the speaker diaphragm is situated) is very high, so that the movement of the cone is greatly resisted. Now at the resonant frequency of the cone, the movement, for a given electrical input to the voice-coil, is very much greater than at frequencies off resonance, and it is this increase of mechanical cone movement which increases the acoustic, or sound output. If then, the column of air behind the cone is made to present a high acoustic impedance to the cone, the latter is unable to execute its over-large movement at its resonant frequency, which is just another way of saying that the cone resonance is damped out by the air in the tube, and is no longer objectionable. At the same time, the sound from the back of the cone is able to issue from the end of the tube approximately in phase with that direct sound from the front, so that the efficiency of the speaker at frequencies above and below the resonant frequency is increased, resulting in better low-frequency performance.

In Fig. 1 we have drawn a generalized diagram of a labyrinth baffle, and the table alongside shows the dimensions that should be used for various speaker sizes. Strictly speaking, the baffle should be specially designed for every different speaker that might be used, but in practice, the dimensions are not as critical as one might expect. In addition, most speakers of the same cone size have approximately the same bass resonant frequency, with the result that a generalized design is perfectly satisfactory unless exceptional speakers are used. For instance, practically all 12 in. speakers have a resonant frequency in the neighbourhood of 70 c/sec., and this is the frequency for which the dimensions of a 12 in. speaker are most suited. The only sort of 12 in. speaker which this design would be really unsuitable for would be one with a particularly low resonant frequency, such as 40 or 50 c/sec. However, such speakers are unusual, and in any event their makers usually recommend a particular style of baffle for them.

As with all baffles, the labyrinth should be constructed of solid material, and for best results, all joints should be screwed and glued. No nails by request! Also, the recommended felt "lagging" should on no account be omitted. If it is, the results in the middle and upper

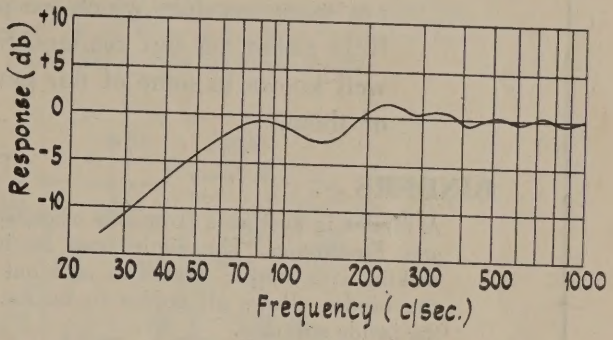

Fig. 3.—Response of same speaker in a base-reflex cabinet.

(Concluded on page 48.)

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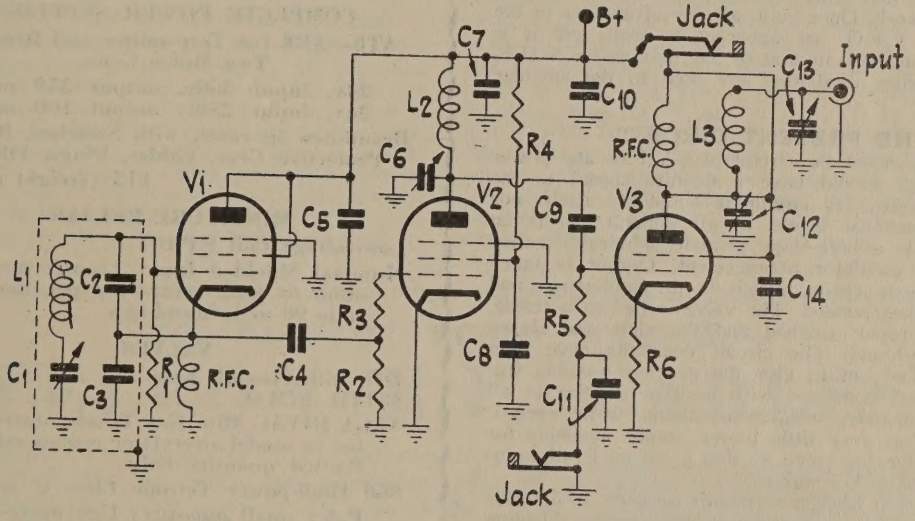
A V.F.O. for the V.H.F. Transmitter

In the April issue of this journal a short article showed how a stable oscillator operating between the frequencies 46.6 mc/sec. and 54 mc/sec. could be used as a V.F.O. to cover not only the six-metre band, which is included in its fundamental range, but also the two-metre band and the 420-460 mc/sec. band. The present article describes a V.F.O. built according to this scheme, and followed on the chassis by a Class A amplifier and a Class C power amplifier, the latter delivering over six watts of R.F. power at any frequency within the range of the oscillator. The unit could be used as a low-powered transmitter for six metres, an exciter for a high-powered stage on the same frequency, or to drive a frequency tripler for two metres. For 420 mc/sec., it could drive two tripling stages.



INTRODUCTION

Last month, in an article entitled "Hitting the V.H.F. Bands," we suggested that for the V.H.F. operator the best solution to the frequency-control problem might be a V.F.O. This would make it unnecessary to invest in a variety of crystals, suitable for frequency multiplication into the higher bands, and need not be any less stable than an ordinary crystal oscillator. It has been pointed out several times in the literature that the Clapp oscillator circuit can work as high as 100 mc/sec., and even at this frequency can confer the identical advantages that it does at much lower frequencies, where it is more commonly used. Accordingly, therefore, our laboratory set out to test the truth of this assertion, and came up with a final answer so practical and simple that we felt it to be well worth publishing for the benefit of those amateur transmitters who already work on the V.H.F. bands, and also in order to provide some encouragement for those who do not, as yet, but who would like to try.

ADVANTAGES OF THE V.F.O.

Not the only advantage of the V.F.O. as applied to six metres and above is that one can work on any frequency within the desired band. As mentioned above, it can save quite a lot of expenditure on crystals, but at the same time it has other advantages. Perhaps the main one is its economy in equipment and in power supply. Where the generation of R.F. has to take place at a low frequency, such as 8 mc/sec., a large string of frequency multipliers is needed, and each of these requires a valve and power to operate it. Consequently,

L_1, L_2, L_3, Osc., buffer, and output tank coils. See text.
C_1, Four-plate midget tuning condenser, in parallel with a midget 20 $\mu\mu$f. air-dielectric trimmer. See text.
C_2, C_3, 50 $\mu\mu$f. silvered mica.
C_4, C_9, 250 $\mu\mu$f. ceramic.
C_5, C_8, C_{11}, 0.001 midget paper.
C_6, C_{12}, midget 25 $\mu\mu$f. variables, C_6 having one stator plate removed.
C_7, C_{10}, 0.1 μf. paper.
C_{13}, 50 $\mu\mu$f. midget variable.
R_1, 50k.
R_2, 3.3k.
R_3, 25 ohms.
R_4, R_5, 100k.
R_6, 250 ohms.

Note.—R_6 should be bypassed by a 0.001 μf. condenser.

with crystal control, one can end up with an exciter which has quite remarkably large power requirements, even before any appreciable power is developed at the final frequency. Such a device is very uneconomic both to build and to operate. Moreover, unless specially built on a single-frequency basis, it is too cumbersome for mobile or transportable use. This disability of crystal control is partially overcome by the use of overtone crystals, or of ordinary ones in overtone oscillator circuits. These latter, though, are tricky, and special overtone crystals are difficult to obtain.

On the other hand, if a V.F.O. is decided upon, it can be made to work directly on quite a high frequency, and will therefore eliminate most of the frequency multiplying stages and their power requirements. A unit capable of acting as an exciter or low-powered transmitter for the six-metre band, for instance, can be very compact as well as very economical in its power supply requirement, so that it lends itself well both to fixed and transportable work. Once built, all the advantages of the low-frequency V.F.O. are apparent as well, and it is a source of wonder to us that so few designs for V.H.F. variable frequency oscillators are seen in the amateur literature.

THE PRESENT CIRCUIT

In Fig. 1 is shown the circuit of a V.F.O. and power amplifier which should have a definite appeal to the V.H.F. enthusiast. Its circuit is simplicity itself, nor is the constructional aspect at all difficult. V_1 is an EF91, which is a high-slope pentode, admirably suited to the Clapp oscillator arrangement. Output is taken from the cathode choke, which is the commonest and probably the best method. The valve is tied as a triode, with the suppressor earthed and the plate and screen bypassed to ground. The circuit constants have been carefully worked out to give the greatest possible frequency stability, combined with positive starting at all times. Unfortunately, such an oscillator, while exceedingly stable, has very little power output available for driving the following stage, so that a second EF81 is included as a Class A amplifier.

As will be seen when next month we come to describe the actual construction of the unit, cross-socket shielding is necessary in order to stabilize this stage, but there is no necessity for concern over possible oscillation, since a low grid-circuit impedance has been provided, as well as a relatively high-C tuned circuit in the plate. Doing this reduces the voltage amplification of the stage, and helps to prevent instability, while the stage still has ample power output to drive the next stage, which is a Class C amplifier, with a useful power output. The Class C amplifier uses a QVO4/7—the tube which is used as the final amplifier in practically all the mobile transmitters of modern design in use today. It is a small transmitting pentode, quite inexpensive to buy, and capable of six or more watts output on frequencies as high as 150 mc/sec. Here, however, it is called upon for only 54 mc/sec., and its output is nearer seven watts than six. One of its outstanding advantages is that it needs only a very small driving power and is easily excited by the output of the Class A stage ahead of it. Since this, too, is a "straight" amplifier, it also needs a cross-socket shield, which is provided in the practical realization of the circuit. Its plate coil is mounted above the chassis and its grid circuit is underneath, so that stability is easily obtained here, too.

COIL DATA

One of the most remarkable features of the Clapp oscillator circuit is the very high ratio of inductance to capacity that it allows one to use. Contrary to conven-

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tional oscillator circuits, the Clapp is more stable the higher the L/C ratio used, other things being equal. The series condensers, C_2 and C_3, have the very high value for the frequency of 50 $\mu\mu$f., while the total tuning capacity amounts to little more than 5 or 6 $\mu\mu$f. The oscillator coil, L_1, consists of $10\frac{3}{4}$ turns of 18-gauge enamelled wire, spaced to occupy a winding length of $\frac{7}{8}$ in. and of $\frac{7}{8}$ in outside diameter. It is of the self-supporting "air-wound" variety, and its construction will be seen in the photographs to appear in the second part of this article.

The plate coil of V_2, L_2 on the diagram, consists of $3\frac{1}{2}$ turns of 18-gauge wire, $\frac{3}{4}$ in. in diameter, and spaced to occupy $\frac{1}{4}$ in. The output tank coil, L_3, consists of 6 turns of 18-gauge wire, spaced to occupy $\frac{7}{8}$ in., and $\frac{7}{8}$ in. in diameter.

Both R.F. chokes are wound with 36-gauge wire to a length of $\frac{7}{8}$ in. on a former $\frac{1}{4}$-in. in diameter.

THE PI-SECTION OUTPUT COUPLING

One of the most efficient methods known for abstracting R.F. energy from a tank circuit is the pi-section coupler, as used in the plate circuit of V_3. It is not difficult to design, and ensures that a perfect match is easily made to any load, whether purely resistive or not. From a single-ended final amplifier, as here, it is suitable only for a single-ended output, such as a co-axial cable, but this has no disadvantage, since the latter is the most efficient means of transferring R.F. from place to place, and can easily be provided with a coupling device at the far end should it have to feed the power into a balanced two-wire feeder or to a push-pull amplifier stage. Basically, it is nothing more than a tuned circuit, in which the capacity branch is split into two parts, their junction amounting to much the same thing as a tap on the coil. But, by making the two condensers variable, a very smooth adjustment of the tap is possible. The adjustment of the condensers is quite simple, as long as two facts are remembered: (1) Adjusting the ratio of the two capacities alters the matching; and (2) adjusting the total series capacity tunes the circuit to resonance.

The best way of familiarizing oneself with the operation of the pi-section is to use a dummy load and an R.F. milliammeter in series with it as an indicator. With this arrangement, maximum current through the milliammeter indicates maximum power dissipated in the dummy load, and, therefore, correct matching. A short piece of co-axial cable—say, three feet or so—can be used to separate the load from the vicinity of the transmitter, and for the dummy load four 6.3 volt 0.25 amp. dial lamps in series will give a resistance of approximately 90 ohms, when lit to full brilliance. Thus, it does not matter if the impedance of the co-axial cable used is not exactly 90 ohms. It may be 50 or 70 ohms, but this will not prevent a match from being obtained. All that happens in a case like this is that there will be slight standing waves on the line, and if this is short, the amount of power lost will be very small.

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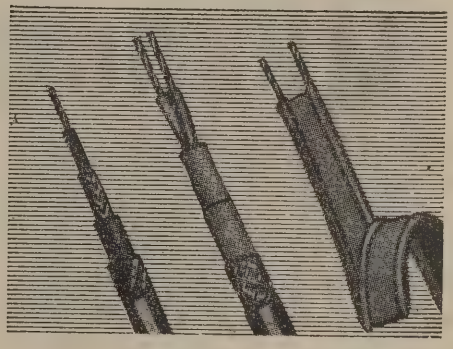
AS.93.M.	PT.9.M.	PT.11.M.	AS.91.M.
		PT.29.M.	

BALANCED TWIN (Screened)

BA.24.PSM. BA.3.PSM.
K.12.SM.



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After tuning up the grid circuit of the QVO4/7, as shown by maximum grid current, the plate and screen voltages of the QVO4/7 are switched on and C_{12} is used to resonate the plate circuit. Meanwhile, C_{13} should be set at about half-scale. As C_{12} is brought into tune, a reading will show on the R.F. milliammeter, so C_{12} is tuned for maximum current, and the reading is noted. Next, C_{13} is increased in capacity, and this de-tunes the circuit, so tuning is restored by re-tuning with C_{12}. This will give a new reading on the meter, and if it is larger than the first, the matching has been improved. We then proceed in the same way, increasing C_{13} in steps, and re-tuning with C_{12} and noting the meter reading after every re-tune. Ultimately we arrive at a stage where further increasing C_{13} causes a drop in the meter reading after re-tuning has been done. This is an indication that the point for the best match has been passed. We then take C_{13} back in small steps until the point for maximum current through the load is found. C_{13} can then be left set, and re-tuning for slightly different frequencies done only with C_{12}, as with a conventional tank circuit.

Some readers might be wondering what sort of R.F. milliammeter should be used as an indicator, and whether they can be bought. Well, they are still to be found in some radio shops, 0-100 ma. thermocouple R.F. milliammeters, and these can be had for about 30s. For anyone interested in transmitting, these are a very good buy, because the same thing would normally cost somewhere in the region of £5 in the ordinary course of events. For larger currents, where the meter is required only as an indicator, it is easily shunted simply by connecting a piece of copper wire across its terminals. For reading high currents, the shunt can be quite heavy, but for low-powered stages, and not very low load resistances, where the load current is small, the meter can be used unshunted. If a resistor of known value is used as the dummy load in place of the lamps, the power can actually be measured with the meter, since the power in the load is I^2R, where I is the current, as shown by the meter (in amps, NOT milliamps), and R is the resistance of the load.

In the next instalment of this article, the construction of the unit will be shown in photographs and described as well. (To be continued)

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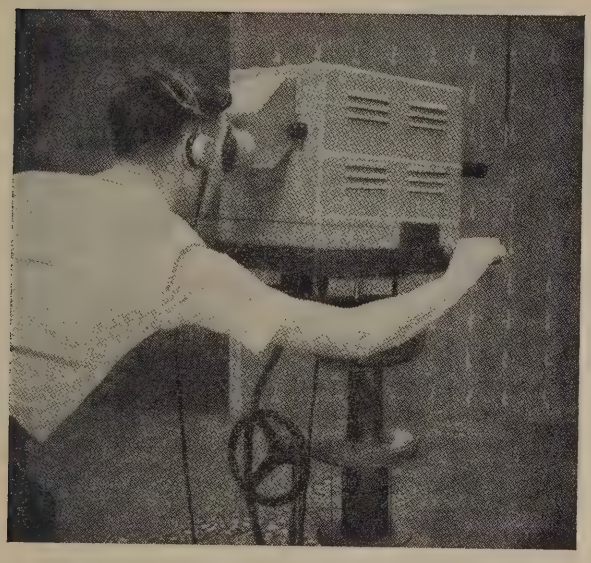
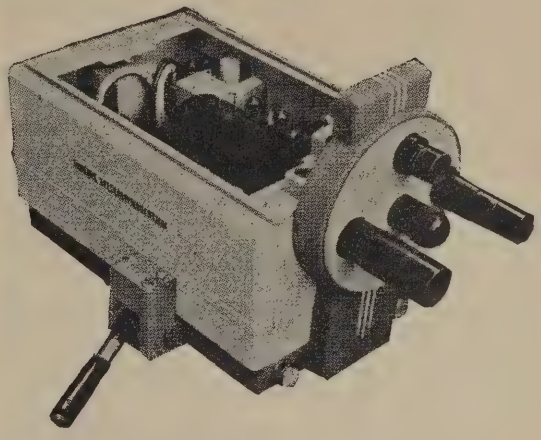
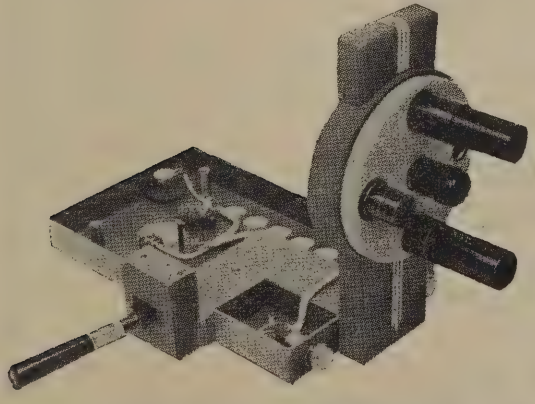




The complete camera, with the electronic viewfinder removed to show the camera tube's housing

Philips' latest TV camera type SBE 521 has been a great success. This camera, in use in the Netherlands TV studios at Bussum, has been so designed that both the work of the cameraman and that of the maintenance personnel has been simplified owing to two particular properties:

1. All operations necessary for adjusting the camera can be carried out by the cameraman by means of a single handle controlling a hydraulic precision drive which finds its first application in TV engineering here.
2. The construction of the camera in individual units which can be taken out separately, makes all components easily accessible. A brief description of the camera follows, elucidated with illustrations.



View of the base of the camera showing the lens turret and the hydraulic operating mechanism.

The operating mechanism for the optical part of the camera is contained in the bottom-plate with which the revolving turret for the four lenses forms an integral unit. Signal lamps on the front of the camera indicate when it is on the air. The receptacles for the camera cable and those for the microphone and telephone of the intercom. system are at the bottom of the camera.

The case mounted directly on the bottom-plate contains the sensitive super-iconoscope, type 5854 and also

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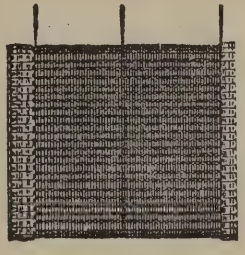

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the time base and video amplifiers. The chassis on which these two units are mounted, can be opened outwards after taking out a few plugs, so that all components are easily accessible.

The components of an electronic viewfinder are contained in the upper case which can be hinged up and also admits of easy access without loosening the wiring. In the viewfinder fitted at the back, an enlarged image is visible through a lense; at the same time various light-signals can be seen, indicating which of the four lenses is in use and in addition whether the camera is "on the air" or not.

With respect to the mechanical design, the illustrations will give a better impression than can be gained from this brief description.

The hydraulic operating mechanism of the optical system deserves special mention. This component of the new camera has rendered it possible to adjust various organs by a single operating handle. The various operations possible with this handle-type control, are:

1. Selecting the correct lens (for this purpose the handle must be pressed downwards. The lens turret will turn 90° so that the next lens is brought before the pick-up tube).
2. Adjusting the diaphragm (by rotation of the lever round its own longitudinal axis, the aperture is adjusted to the value required). The diaphragm of all four lenses is changed simultaneously in such a way that when having adjusted one diaphragm for a definite light intensity, all other lenses can be brought in front of the pick-up tube without having to change the aperture again.
3. Focusing (by moving the handle in a horizontal plane the lens in use can be focused. Just as in (2) the focus of the other lenses is adjusted simultaneously so that after lenses have been changed, a sharp image is obtained at once.
4. Selection of one of the available filters by rotation of the filter disc (the filter disc is rotated step

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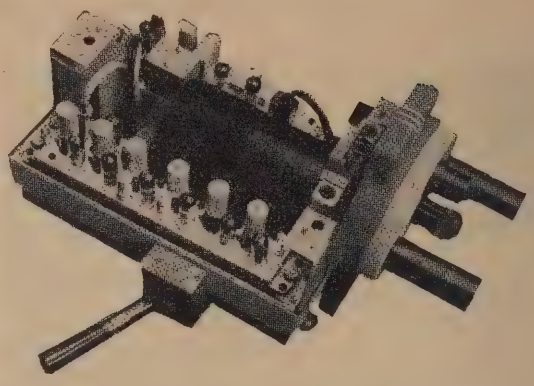

Showing the completely shielded camera tube and its time-base and amplifier circuits

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THE LATEST DEVELOPMENTS IN RADIO SCIENCE

DR. C. ELLYETT ADDRESSES CHRISTCHURCH BRANCH

Dr. Ellyett described proceedings at the recent U.R.S.I. Conference held at Sydney, N.S.W., giving a close-up of recent technological developments reported there by representatives of twenty nations.

Sydney was chosen as the meeting place mainly because of the outstanding importance of research by Australian scientists in radio astronomy. Early in his address, Dr. Ellyett mentioned an important fact about U.R.S.I.—this body, virtually a United Nations scientific organization for research, was formed long before the political U.N., its members representing nearly every country outside the Iron Curtain.

He found that the social "get-togethers" of scientists of many nations working in the same field, in pleasant fireside conversation during the evenings after formal business, were of as much benefit to him as the day sessions, in the promotion and stimulation of ideas, and the making of valuable new friendships. An unforeseen result was that the majority of the 340 scientific papers prepared for formal discussion which were distributed to delegates on arrival had to be bundled up and sent home, as there was no time left in which to study them at the conference.

There was an excursion to A.W.A.'s large factory, which was efficient and well run, and an inspection of Australian-made test equipment and scientific apparatus at the Sydney University physics department. He noted that the range was comprehensive except for test gear of superfine specification.

A most interesting use of TV was demonstrated in the teaching of zoology. A difficult job to show clearly to students, the sectioning of a fish, was shown clearly by TV, detail being extraordinarily good on the screen. Also, by TV, a drop of water was magnified so highly that the heart-beat of minute insects within could be seen plainly.

Turning to information from U.R.S.I. reports, Dr. Ellyett mentioned improvements in accuracy of new commercial signal generators—better than 5 parts in 100,000, due to wider use of quartz crystal control and the improvement in grade of components by improved quality control in the manufacture.

Synthetic crystals were now as good as natural quartz in all respects.

In Holland and U.S.A., electronic counters were being applied to frequency measurement and indication. The use of a magnetic field for the control of microwave energy in waveguides was a new development. Ferrite materials were being used for attenuation, modulation, and feedback and pulsing or keying on very high frequency equipment.

Exciting things were happening in tropospheric research in V.H.F., U.H.F., microwave, and TV fields—new facts now known about ducting, in the atmosphere, channelling of signals, and extension of coverage.

The Japanese, surprisingly, had nation-wide police force linked by a 30 megacycle net, and even the village policeman co-operates in a mass study of V.H.F. signals.

Ten countries were working in the field of V.H.F. propagation and the important news emerging therefrom was that ranges are greater than theoretically calculated heretofore and better than can be accounted for by the ducting phenomenon.

Turbulence in the air has been found to cause "scattering" with a result that signals are reflected to points much more distant than line of sight.

A study of the attenuation of 90 megacycle signals through the housing and building effects in towns and cities showed that with a given antenna of 18 ft. height, signals were down 10 db. as compared with a clear path over open fields.

Dr. Ellyett told us that radically new ionospheric recording equipment was in use for determining MUF by automatic sounding. One new type in use in India was now recording E, F_1, and F_2 layer heights within a three-quarter kilometre, and in America, recorders were being used to determine the rate of change of ionization of layers. For example, three sounding transmitters spaced thirty miles apart produced entirely different results at a given time.

The National Bureau of Standards in Washington was using radiosonde to sweep 50 kc/sec. to 1 mc/sec. with 100 microsec. pulses, using loop aerials and high transmitting power. It was discovered that the E layer does not disappear at night-time as was formerly believed.

In Canada, 300 KW pulses are being used for sweeping from 200 kc/sec. to 4 mc/sec. in a study of layer heights in the Arctic region. A communications zone indicator has been devised (COZI) which sends 1 kw. of energy in pulses obliquely towards the ionosphere from a rotating Yagi array. A reflected signal from the first hop point on the earth's surface was fed to a PPI, enabling ionospheric conditions in a circle of 400 miles radius to be viewed on the screen.

It was found that, with signals from 40 to 100 megacycles, some energy was always received by ionospheric scattering, within a range 1000 to 2000 km. Signals were weak but always present. Twenty kw. was in use for these tests in Canada and the U.S.A. Also, the received signal was not affected by sunspot activity; communications and defence chiefs were very interested, particularly because signal strength actually increased during sunspot periods, pointing to the scattered height being at the bottom of the ionosphere. This is one very good reason why measurement of the low layer heights to three-quarters of a kilometre has become of great importance.

Mr. Appleton has recently stated his belief that very high frequencies would eventually transcend present-day frequencies in importance.

At Pitcairn Island, in wartime, and at other noise-free sites, low layer echoes had been noted, and recently similar results had been noted at Campbell Island.

At Sydney, N.S.W., a weekend lowering in noise-level had been noted at an observation point 40 miles distant, proving that random R.F. noise from electrical machinery in the city was reflected from the ionosphere.

Work is now going on in New Zealand on building an aerial array covering 15 acres for further low layer studies of the ionosphere.

Another investigation of aurora echoes shows that the curtain or display travels at 2,000 m.p.h. at a height of 300 to 40 kilometres.

Calculations have been made of the power likely to be received if radar echoes from the planets can be obtained. It is known that the power at the receiver input resulting from echo signals is—

$$\propto \frac{A}{R^4}$$

where

A = echoing area

R = range.

A large aircraft 2000 km. = $A/R4.3 \times 10^{-20}$ metre^2

The moon $3.8 \cdot 10^5$ km. = $3 \cdot 10^{-23}$ metre^2

Venus $3.7 \cdot 10^7$ km. = $6 \cdot 10^{-30}$ metre^2

Neptune $4.2 \cdot 10^9$ km. = $7 \cdot 10^{-37}$ metre^2

In the case of the moon, pulse length must exceed the diameter of the moon face, i.e., greater than 11.6 millisec., to keep the reflection from the whole surface in phase. The receiver must consequently have extremely narrow bandwidth so that, with a pulse of 250 millisecs., 3 kw. power at 2.6 m., the bandwidth of the receiver will be 57 cycles.

With the huge new paraboloid aerial now being built by the University of Manchester, although the sensitivity required to detect Venus is up by a factor of 10^7 on the moon, an echo should be obtained if 200 kw. power is used together with a 1 sec. pulse. Echoes should also be obtained from Mars, Mercury, and Jupiter.

As a result of echo measurement and the plotting of the E layer by workers under Ratcliffe in England, proof now exists of the presence of high winds in the ionosphere. At heights above 60 miles, wind streams had been plotted, plus attendant turbulence. It was found that stream direction changed through 360 degrees twice a day, and speed was 200 m.p.h. Further, it was found that above 80 km. one stream existed travelling in a vast rotary course in one direction which was matched by a second stream below 80 km. travelling in the opposite direction.

Experiments have resulted in a new radiation formula for all frequencies. It is known that power emitted

$$= \frac{2\pi kt}{\lambda^2}$$

where k is a constant, t = temperature, and π = frequency range being measured. A method of measuring the temperature of the moon, using solar microwaves reflected from its surface, has been deduced, so accurate that a change of 8 deg. can be easily measured. The exploring signal has been shown to penetrate a dust layer 16 inches thick, which is shown by calculation to be present all over the moon's surface. Because the moon has no atmosphere, meteors continually crash into its surface, causing the dust layer. Incidentally, 8000 meteors enter the earth's atmosphere daily. This calculation is supported by the thousands of pits found on the surface of rockets shot up to the top of our atmosphere.

In work on noise radiation from the sun being carried out at Cambridge, England, the location of sunspots to within an angle of 10 seconds has become possible through use of a highly directional aerial system whose pattern can be controlled by a phasing method which effectively rocks the aerial pattern across the face of the sun.

Dr. Ellyett next said that in the galaxy of stars of which the sun is a member, there are 100,000 million 20,000 light years deep and 100,000 light years wide. Professor Jansky detected noise from the Milky Way—"the wide" direction of our galaxy—in 1931 with relatively simple gear. There are other galaxies, the nearest being that of Andromeda, 750,000 light years away, and it is certain that many more nebulae or galaxies exist totalling more than 10 to the ninth power. Also, there are point sources of noise with no corresponding visible

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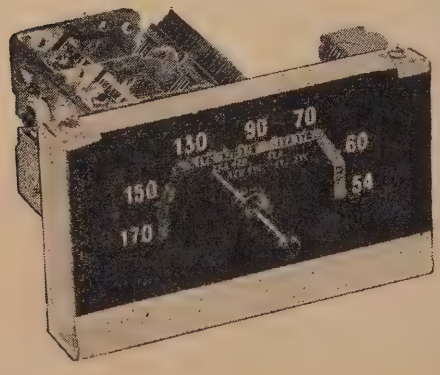

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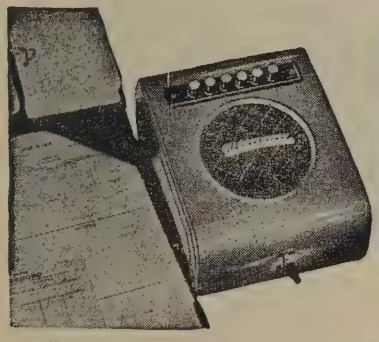

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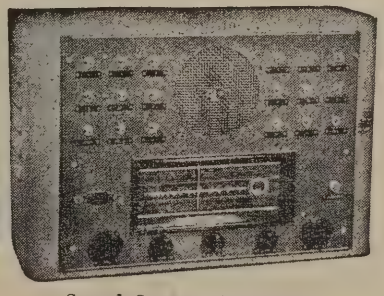

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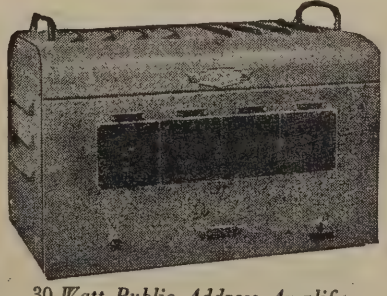

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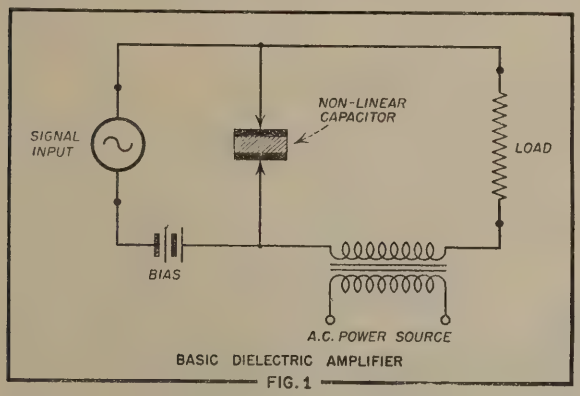


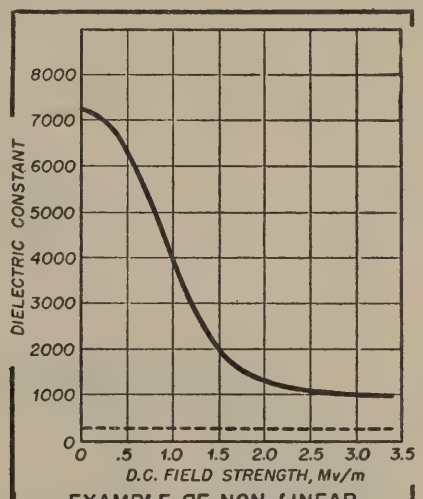
BASIC DIELECTRIC AMPLIFIER
FIG. 1

resulted in the invention and development of the transistor, the magnetic amplifier, and the dielectric amplifier. All of these approaches hold great promise of alleviating the "tube problem" in certain fields and are of interest to workers in electronics. This article is devoted to a practical discussion of the characteristics of the latter device.

The dielectric amplifier finds its major field of use as a D.C. or low-frequency A.C. amplifier in "work horse" circuits where special characteristics of vacuum tubes are not needed. Its upper frequency limit appears to be in the vicinity of 10 megacycles at the present stage of development, although time may prove that appreciable extension is possible, as was the case with the vacuum tube. Having the same basic structure as a capacitor, it has none of the fragility of a tube and is much cheaper to construct. Requiring no vacuum and having no filament or heater, it is much more reliable—an important consideration in today's electronic warfare where the failure of a single 6AK5 can cause a ten-thousand dollar bomber mission to "abort." And, because of the extreme simplicity of its construction, the dielectric amplifier should be easy to mass-produce with uniform characteristics—a difficult accomplishment with vacuum tubes.

PRINCIPLES OF OPERATION

Fig. 1 shows the basic circuit of the dielectric amplifier. It consists of a special capacitor connected in such a manner that the application of a small signal voltage to the "input", or "control", circuit causes a variation in the capacitance of the unit and hence a change in the alternatiing current flowing in the "output", or "load", circuit. The power variation may be many times greater than the power change in the input circuit which produced it. Hence the device is a practical amplifier.



EXAMPLE OF NON-LINEAR DIELECTRIC CHARACTERISTIC
FIG. 2

The capacitor used in dielectric amplifiers must have what is known as a *non-linear* capacitance characteristic, i.e., the dielectric constant, and therefore the capacity, changes with the value of applied voltage. This non-linear property is exhibited by capacitors which are constructed with *polycrystalline* dielectric materials which show *ferro-electric* effects. Ceramics which have been used most extensively to date include barium titanate, strontium titanate, barium zirconate, lead zirconate, and various combinations of these. (It is interesting to note that barium and strontium *carbonates* are the materials most commonly used to coat the cathodes of vacuum tubes.) The study of dielectrics of this type is relatively new and it is probable that further research in ceramics will yield more useful varieties.

The dielectric "constant" versus applied electric field strength of a typical non-linear dielectric is plotted in Fig. 2. The characteristic of a standard "linear" capacitor is shown in dotted lines for comparison. Changes in dielectric constant exceeding 10:1 have been observed in practice. Initial constants for typical non-linear dielectrics in common use range from 1000 to about 9000.

DIELECTRIC FUNDAMENTALS

To gain a working knowledge of the operating principles underlying the dielectric amplifier, a review of the fundamental properties of dielectric materials is profitable. It will be recalled that a dielectric is an insulating body in which electronic conduction is essentially impossible because of the fact that all electrons are firmly bound to their atomic nuclei, so that very few free *valence* electrons are available for current conduction.

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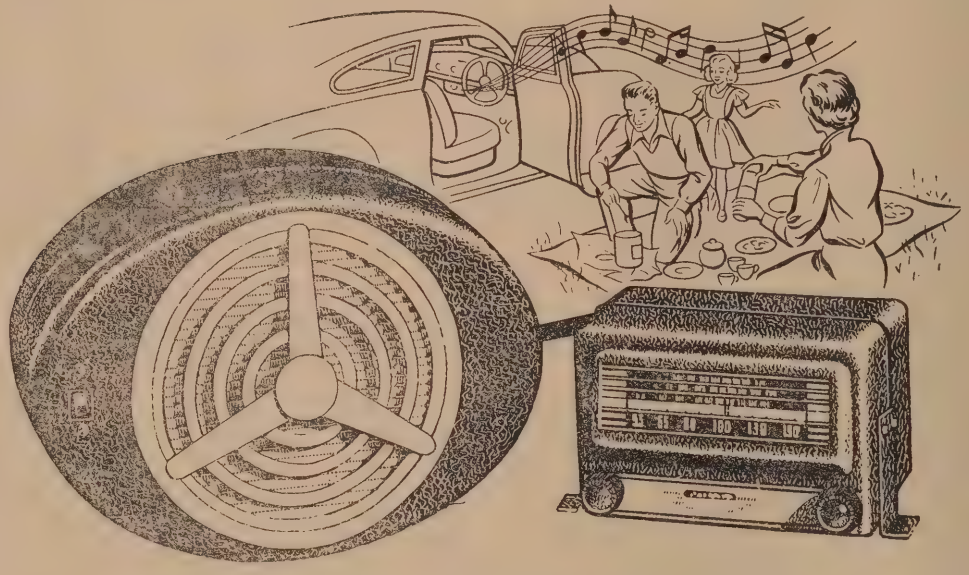

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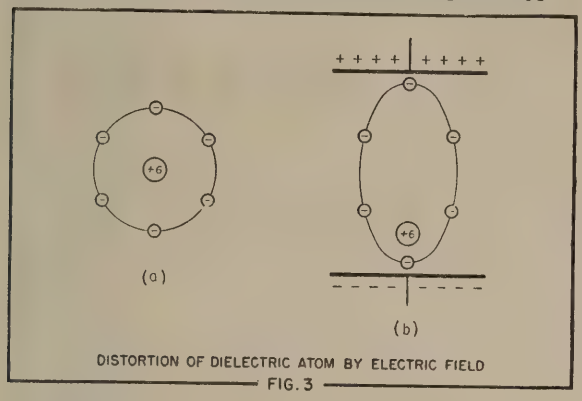
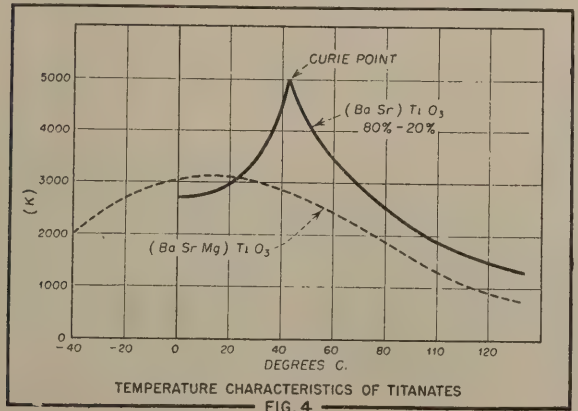
Thus, when the atoms of a dielectric material are "at rest," the structure of the individual atoms can be visualized as in Fig. 3 (a), which represents a positive nucleus surrounded by a symmetrical system of electrons held captive by the positive charge of the nucleus. However, if an electric field is impressed upon a hypothetical dielectric made up of such atoms, the system is distorted by the forces set up by the field, so that it is no longer symmetrical, as illustrated in Fig. 3 (b). In this condition, the atom is called an *induced dipole,* and the dielectric is said be to *polarized.* If the impressed electrostatic field is removed, the atoms revert to the symmetrical condition.



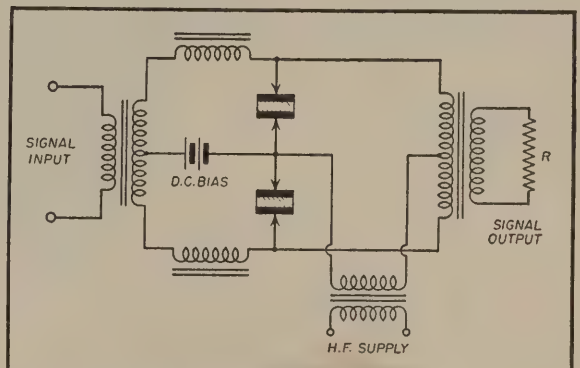
DISTORTION OF DIELECTRIC ATOM BY ELECTRIC FIELD
FIG. 3

The result of the polarization of a dielectric material is that surface charges are set up on the surfaces of the dielectric adjacent to the charged electrodes which apply the polarizing field. These surface charges act to reduce the electric field within the dielectric, compared to what it would be if the dielectric were not present. In other words, the *permittivity* of the space between the electrodes is decreased. The reduction of the internal field depends upon the amount of distortion of the atomic structure; the degree to which the dielectric can be polarized. This is found to be essentially constant for any given type of conventional dielectric material and is for this reason termed the "dielectric constant." Materials with low constants undergo only slight deformation of the atoms, while those with high dielectric constant (K) experience greater distortion.

The non-linear dielectrics differ from the more common types principally in that the amount of distortion, or polarization, is not constant, but varies with the impressed electric field. Therefore, the dielectric constant is not "constant." With it, of course, the capacity and reactance of the condenser change also. The other unique characteristic of these special dielectric materials is their extremely high dielectric constants, as mentioned above. This means that great distortion of the molecular structure is taking place. (Metals are sometimes considered dielectrics of *infinite* dielectric constant since extreme distortion of the atoms—including the complete removal of valence electrons—takes place, and the internal fields fall to zero.)



TEMPERATURE CHARACTERISTICS OF TITANATES
FIG. 4



PUSH-PULL DIELECTRIC AMPLIFIER
FIG. 5

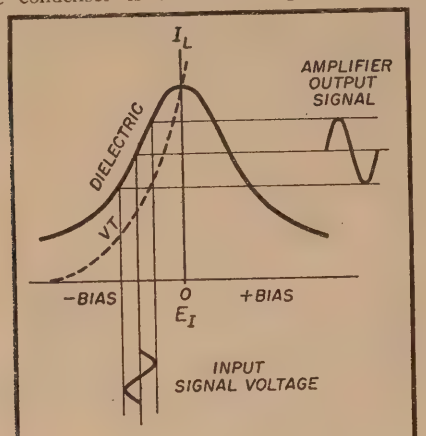
One difficulty that is encountered with the presently available grades of non-linear dielectrics is the dependence of the dielectric properties upon temperature. This is illustrated in Fig. 4, which is the curve of dielectric constant versus temperature for a barium-strontium titanate body of 80%–20% consistency, respectively. The temperature at which the dielectric constant peaks is known as the "Curie point." Different ceramic mixtures have widely differing Curie points. Dielectric amplifiers are usually operated on the negative slope near the peak. Changes in the temperature of the material can cause gain instability unless special measures, such as temperature regulation or compensation are applied. Hence, again, further research is expected to unearth improved materials having less temperature dependence. The dotted curve of Fig. 4 represents one example of this. By combining magnesium titanate with the usual barium-strontium titanate mixture, one firm has produced a ceramic having much more uniform dielectric properties at room temperature. It will be noted that the maximum dielectric constant is reduced, but occurs over a much greater range of temperature.

PRACTICAL CONSIDERATIONS

A practical circuit for a dielectric amplifier is given in Fig. 5. Here two non-linear capacitors are employed in a push-pull arrangement. Transformer input and output matching is used for impedance considerations and for added voltage gain. A high-frequency alternating current power supply must be used in the "plate" circuit of any dielectric amplifier, since a change in the reactance of the control capacitor can only have an effect on alternating current. A self-rectifying radio-frequency power oscillator is commonly utilized for this power source.

The chokes shown in Fig. 5 are for the purpose of isolating the signal input circuit from the A.C. power in the output circuit. The D.C. bias serves to place the

operating point on a suitable part of the characteristic curve of the particular dielectric used. A typical curve of input voltage versus output current for a barium titanate condenser is shown in Fig. 6. Note that this

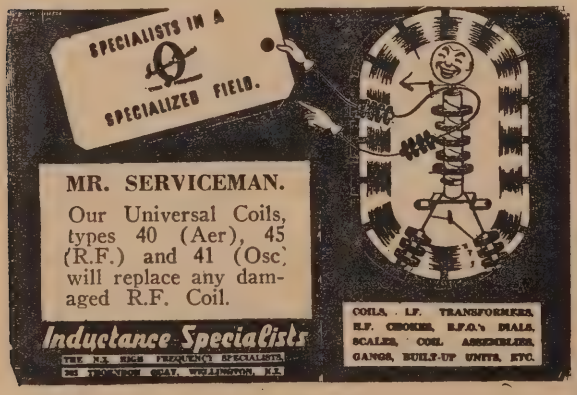


COMPARISON OF DIELECTRIC AND VACUUM TUBE AMPLIFIER CURVES

FIG. 6

curve bears a resemblance to the Eg-Ip characteristic of a conventional vacuum tube amplifier (dotted line, Fig. 6) with the exception that it is symmetrical about the zero bias axis. This symmetry of the transfer characteristic is due to the fact that the reactance of the non-linear capacitor is increased by either a positive-going or negative-going signal at zero bias. In other words, an electric field of either polarity causes the dielectric constant to vary. The vacuum tube characteristic normally has only a positive slope. Another point of difference is that complete cut-off of output current does not occur in the dielectric amplifier as in vacuum tube devices. This follows since the dielectric constant never becomes zero, as is indicated by the plateau on the right-hand side of the curve of dielectric constant versus applied electric field shown in Fig. 2.

Dielectric amplifiers are usually biased for operation on the most linear portion of the positive slope as in conventional Class "A" operation, although other manners of operation are possible. If operated at zero bias, the dielectric amplifier acts as a frequency doubler.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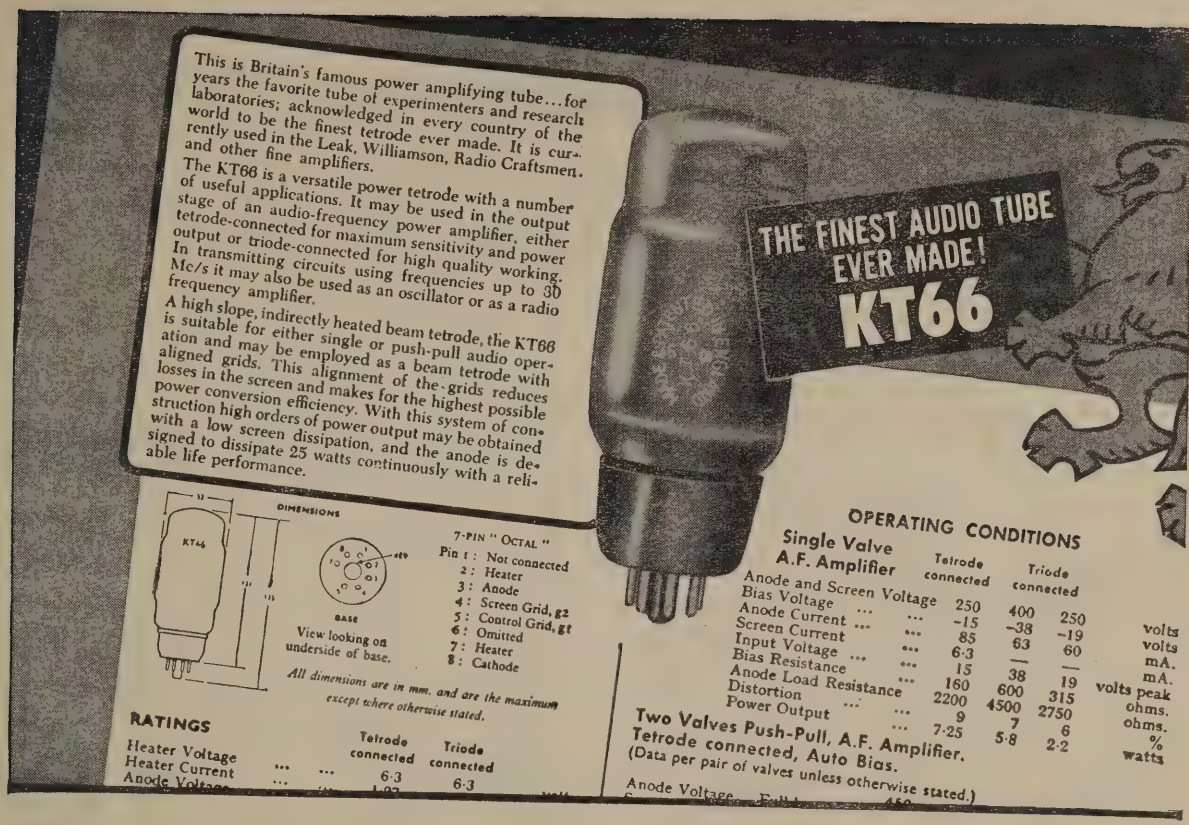
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DIMENSIONS
KT66
BASE
View looking on underside of base.
7-PIN "OCTAL"
Pin 1: Not connected
2: Heater
3: Anode
4: Screen Grid, g2
5: Control Grid, g1
6: Omitted
7: Heater
8: Cathode
All dimensions are in mm. and are the maximum except where otherwise stated.
RATINGS
Heater Voltage ... ... Tetrode connected 6·3 Triode connected 6·3
Heater Current ... ... 0·6 0·6 amps
Anode Voltage ... ... 1,000 1,000 volts
Anode Dissipation ... ... 25 25 watts
Screen Dissipation ... ... 2·5 — watts
Cathode Current ... ... 0·175 0·175 amps
Grid Resistance ... ... 0·05 0·05 megohms
Bulb Temperature ... ... 250° C. 250° C.
Ventilation: Adequate ventilation around the bulb should be provided.
The circuit information given does not imply any licence under any patents which may be involved.
OPERATING CONDITIONS
Single Valve A.F. Amplifier
Anode and Screen Voltage 250 400 250 volts
Bias Voltage ... ... −15 −38 −19 volts
Anode Current ... ... 85 63 60 mA.
Screen Current ... ... 6·3 — — mA.
Input Voltage ... ... 15 38 19 volts peak
Bias Resistance ... ... 160 600 315 ohms.
Anode Load Resistance 2200 4500 2750 ohms.
Distortion ... 9 7 6 %
Power Output ... 7·25 5·8 2·2 watts
Two Valves Push-Pull, A.F. Amplifier. Tetrode connected, Auto Bias.
(Data per pair of valves unless otherwise stated.)
Anode Voltage ... 450
Anode Current 395 475
Screen Current ... ... −40 360 volts
Anode Dissipation, per valve ... ... 80 −40 volts
Screen Dissipation, per valve ... 3 175 mA.
Input Voltage, grid to grid ... 21 19 mA.
Load Resistance, anode to anode ... 0·6 17 watts
Distortion ... ... — 3·5 watts
Power Output ... ... 5000 80 watts
† Stabilised screen supply voltage 5000 volts
— — 5 ohms.
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A Condenser Buster

Modern production methods call for modern equipment and one is continually being surprised by the variety of different instruments necessary to obtain information on specific problems. One such piece of equipment seen recently in Wellington was an elaborate set-up for testing condensers and, if necessary, deliberately breaking them down.

The instrument, which goes under the name of an ionization tester, is built in two units—one a control unit which, as the name suggests, controls the nature and extent of the test; and the other, connected by a long cable, being the extra high tension unit. This last-named unit is capable of an output of 25,000 volts, which commands for it a considerable amount of respect.

The control unit includes the power supply for the low voltage valves, an amplifier with volume control, loudspeaker, microammeter, and voltmeter. There is also a single control on this unit which governs the output of the high voltage unit and by increasing this control the condenser under test can be subjected to varying voltages.

Just prior to breakdown of the condenser, ionization takes place and this agitation of electrons is amplified and is presented in the form of noise from the loudspeaker. Is is a characteristic rasping noise which is easily recognizable, and if the test voltage is increased is accompanied by sharp popping as the dielectric breaks down. The ionization currents are measurable by the microammeter and also a direct reading is given of the voltage in KV applied to the condenser under test.

The extra high tension unit, however, is the interesting one since its high output is derived from an R.F. power supply. A local oscillator valve, in this case a 6V6 (fed by normal voltages from the control unit) is used to light the filaments of three high voltage rectifiers by R.F. and at the same time drives the grid of an 807 tuned amplifier.

In the plate circuit of the 807 a large air-cored transformer steps the R.F. voltage up to a high level from where it is fed to the three rectifiers arranged in a voltage trebler circuit. The magnitude of the output voltage is governed by the screen voltage applied to the 807 which is variable at the control unit. It seems to provide a very smooth control of the high voltage output. Provision is made for discharging the test piece through a 100 megohm resistor chain by means of an earthing device. One can readily understand the necessity for this for a condenser charged to several kilovolts can deliver more than a playful tap to the unwary.

The actual mechanical construction of the E.H.T. unit itself is interesting since all sharp projections have to be protected by corona bells to stop corona discharge, even the sockets of the high voltage rectifiers themselves have these protective domes completely covering the solder lugs.

One may wonder at first how electrical disturbances in a condenser under test at anything up to 20 KV can be "got at" to provide a useful signal for amplifying in order to get an audible idea of what is happening. In practice, it is quite simple, although no doubt it exercised the designer's mind somewhat. The low side of the test condenser instead of being connected directly to earth is lifted by a half meg. resistor. Minute variations in current through the condenser then cause voltage fluctuations of a usable size across this resistor; this signal voltage is fed to the grid of a cathode follower valve, which in turn feeds through the control cable into the control unit amplifier.

Another cathode follower valve which derives its grid drive from a high resistance dividing network across the test piece is used to actuate the meter in the control unit measuring kilovolts applied to the condenser.

It can be seen then that condenser "busting" calls for more than just ordinary equipment when reliable information and data are required.

No. 5

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The outstanding advantage of cold cathode lighting is that maintenance costs are minimum compared with other types of fluorescent lighting. The lamps operate with higher voltages and lower currents than do hot cathode fluorescent lamps. A cold cathode lamp has a cylindrical electrode at each end which works at a much lower temperature than the filaments in hot cathode lamps. Apart from this, the mode of producing light is the same as in any other fluorescent lamp.

Cold cathode lamps may be operated from a ballast or they may be wired in series across the secondary winding of a special high voltage transformer. The transformer may have a rating as high as 15,000 volts and deliver a current up to 60 ma. or even higher.

Because the cold cathode lamps are usually much longer than hot cathode lamps of the same light output the brightness per unit length of lamp tube may be somewhat lower than that of ordinary fluorescent lamps. This means less strain on the eyes and a more pleasant light. Two other advantages are that often lamp tubing can be bent to almost any desired shape and that cold cathode lamps lend themselves to use in flashing and dimming circuits. Places such as factories, shops, theatres, hospitals, subways, ships, etc., offer good opportunities for the use of cold cathode fluorescent lighting.

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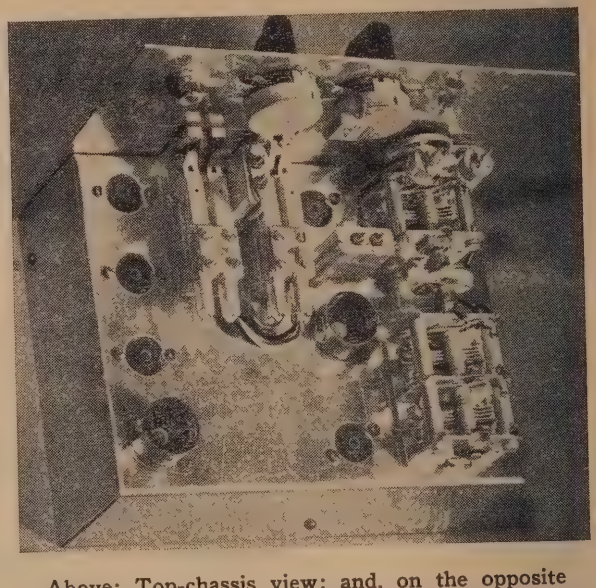
CONSTRUCTION OF THE RECEIVER

(Continued)

In last month's instalment, we gave working drawings for the chassis used for the receiver and modulator circuits, together with a photograph of the completed front panel. The two photographs printed here show the above-chassis view and a view of the underneath. Both these have been taken at the stage where the receiver proper is completely wired up, but not the audio circuits for the receiver and modulator sections. This was done purposely, so as to make the photographs clearer. Looking at the top-chassis view, taken from the back, we see on the left-hand side of the chassis (the right-hand side of the photograph) the ganged tuning condensers, with the R.F. valves in a row beside them. At the back of the chassis, right next to the rear section of the gang, is the Philips EF92 R.F. amplifier socket. Behind that, in the photograph, is the Rimlock socket for the ECH41 oscillator-mixer valve. Behind this again can be seen the first I.F. transformer, which is a Philips miniature Ferroxcube-cored unit. Behind this again, and between the front gang section and the Phone/C.W. switch, is the socket for the EF92 I.F. amplifier valve. Then, sandwiched in between the two leaf switches, is the second I.F. transformer, of the same type as the first. The EB91 second detector and A.V.C. valve is the one whose socket is in the front right-hand corner of the chassis.

In the under-chassis view, it can be seen that a baffle-shield runs on a 45-degree slant from about the centre of the front edge of the chassis to the wave-change switch, where there is a bend in the shield, and it then runs parallel to the front and back edges of the chassis. This baffle shield crosses the socket of the R.F. valve, which is seen near the extreme front end of the shield, so as to separate the input and output circuits. The shield encloses the aerial coil and all its associated components, isolating them from the plate pin of the R.F. valve and from all the grid-circuit components of the mixer stage.

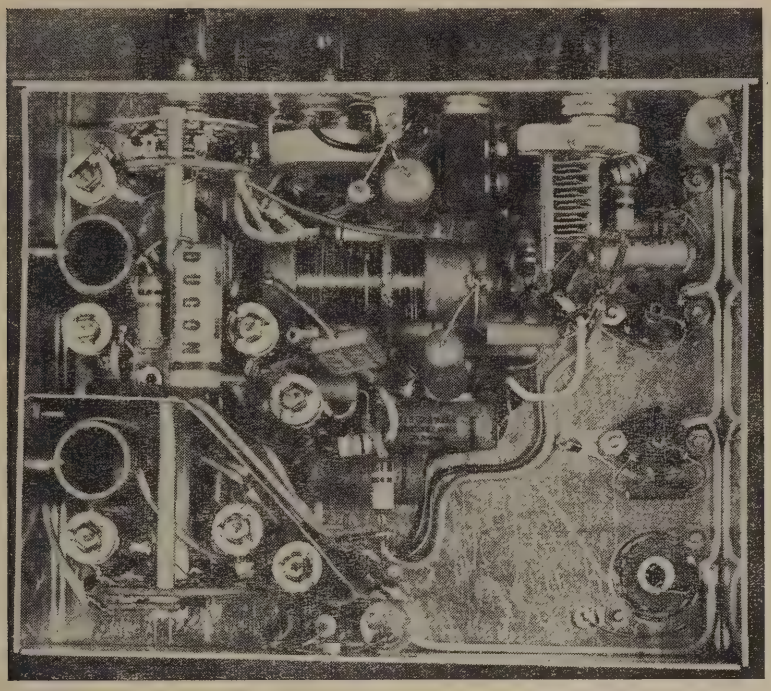
The aerial coil can be seen in the front left-hand corner of the chassis in the underneath photograph. Behind it, on the other side of the baffle shield, is the R.F. coil. Both these coils are mounted vertically, with the 80-metre windings farthest from the chassis—i.e., nearest the viewer. The wafer carrying S_{1a} and S_{1b} is the one at the extreme end of the switch, and is inside the shielded compartment. The second wafer, carrying S_{1c} and S_{1d} is just behind the baffle shield, while the remaining wafer, with S_{1e} and S_{1f}, is the one mounted close up to the front end of the switch. C_1, C_4, and C_6, the Philips trimmers associated with the aerial coil, can be seen inside the shielded compartment. The one nearest the R.F. valve socket is C_1, the one next to the coil is C_6, while the one in between the other two is C_4. Then, behind the baffle shield in the photograph are the three trimmers, C_{10}, C_{13}, and C_{14}. The latter is the one nearest the R.F. coil, while the one nearest the condenser marked "DUCON" is C_{13}, and the remaining one is C_{10}. The trimmer nearest the front of the chassis is C_{18}, the series trimmer on the oscillator circuit. C_{22} and C_{23} are the two trimmers that can be seen mounted on the front gang section in the above-chassis view. The coil placed horizontally is the oscillator coil, and its leads can be seen going to the switch wafer nearest the front of the chassis.



Above: Top-chassis view; and, on the opposite page, under chassis view of the receiver. The lay-out of the main components is described in detail in the text.

The potentiometer next to the wave-change switch is the manual R.F. gain control, R_{22}. Next to it is the headphone jack, and to the right again is the B.F.O. pitch control condenser.

Of the three unwired sockets seen in the underneath view, the one nearest the front of the chassis is that for the B.F.O. valve, the middle one is ECC91, and the back one is for the modulator valve, the EL41. The bare space in the chassis is where the modulation choke will go.



THE MAIN TUNING GANG

For the main tuning gang condenser, it was not possible to get a three-gang of the right physical and electrical size. However, the midget Polar tuning condensers that can be obtained in singles and two-gangs are made up into a three-gang, as the photograph shows. The dial is a small Eddystone, complete with planetary reduction drive, and is directly coupled to the shaft of the single condenser. This is used for the oscillator tuning, and is coupled with a flexible coupling to the two-gang unit. When purchasing these condensers, make sure that the single one has a shaft coming out at each end of the frame, otherwise it will not be possible to couple it up to the two-gang unit.

The correct condensers to buy are those with close-spaced plates and having three stator and four rotor plates each. They are listed as having a capacity range from 5 to 25 $\mu\mu$f., and the sections of the two-gang version are identical with the single condenser. Thus it is possible to gang them up without any difficulties with different minimum or maximum capacities.

ADJUSTING THE TUNED CIRCUITS OF THE RECEIVER

When the original model was made, great care was taken over the winding of the coils. It will have been noticed that the aerial and R.F. coils have identical numbers of turns. The coils were set up by duplicating the conditions it was expected to meet in the final set-up, and adjusting their inductance until the correct frequency ranges were covered exactly. With the 40-metre coils, it was found that absolutely no adjustment was required, since the slight change in inductance due to installing the coils in the chassis can easily be compensated by adjustment of the parallel and series trimmers. With the 80-metre coils, too, very little difficulty was experienced. The oscillator coils' frequency ranges were exactly right, but it was found that a very slight increase was needed in the inductance of the 80-metre aerial and R.F. coils. However, there is an easy solution to this problem which made it unnecessary to take the coils out and rewind them. This would have been a major undertaking, and it was felt that those duplicating the set could just as easily follow the adjusting procedure worked out in the laboratory. Accordingly, the coils were not modified in any way, and the numbers of turns specified earlier in the article were adhered to.

The first thing to do in getting the frequency ranges correct is to adjust the oscillator coils, since it is these that determine what range is covered by the receiver. After this has been done, the signal circuits can be brought into line with the oscillator coils simply by peaking them for maximum output at both ends of the bands.

There are two methods which can be used for adjusting the oscillator circuit. The first of these is to measure the oscillator frequency with a beat frequency meter. This is a useful method for use in the "ham" shack, since almost everyone these days possesses a beat frequency meter of some sort. For the 80-metre oscillator circuit, with the I.F. at the usual figure of 455 kc/sec., the range covered by the oscillator coil must be 3955 to 4415 kc/sec. if the band is to be just covered. If the gang is set to minimum capacity, and the frequency meter is set to the higher of these frequencies, all that is necessary is to adjust the trimmer C_{22} until the zero beat is heard. Then the gang is turned fully in, and the frequency meter is tuned until the beat is heard once more. If the frequency is lower than 3955 kc/sec., all is well, as this means that the coverage of the circuit is sufficient. But if the minimum frequency is not low enough, it is an indication that the inductance of the coil is too high, and will have to be reduced. Seeing that the oscillator coil is mounted in the clear, it is not a difficult matter to take it out and take a turn off the 80-metre coil. It is then replaced and the measuring procedure is repeated. When the inductance is correct, the circuit can then be set up so that the required band is centred on the dial, with a slight overlap at each end. Thereafter the oscillator coil is not touched, all remaining adjustments being to the aerial and R.F. coils and their condensers.

The alternative method of adjusting the oscillator circuit is to use the beat frequency meter as a signal generator, or to use an actual signal generator. First of all, the I.F. stage is accurately aligned to 455 kc/sec., and next, the signal is fed directly to the grid of the mixer valve, with the R.F. stage unplugged. A signal is first fed in on 3960 kc/sec., and, with the gang set at minimum, the trimmer C_{22} is used to tune in the signal. Then the gang is turned fully in, and the signal generator is re-tuned until the signal is picked up once more. If it is 3500 kc/sec. or slightly lower, no adjustment to the oscillator coil is needed, but, if it is higher than 3500, it wil be necessary to reduce the oscillator coil's inductance, as before.

(Continued on page 42.)

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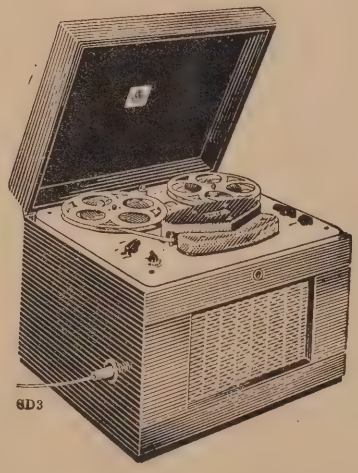

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EMI

The "RADIO and ELECTRONICS" Abstract Service

AUDIO EQIUPMENT AND DESIGN

The article deals with binaural radio broadcasting, its history, and the present growing interest. It had been shown that surprising benefits can be achieved by transmitting two channels —AM for one channel and FM for the other, but FM offers the logical medium. Binaural radio sound reproduction provides Nature's two-ear listening facility, and when stereo-television with binaural sound becomes available, fatigue will be greatly reduced and the effects enhanced.

—Audio Engineering (U.S.A.), Jan., 1953, p. 14.

Refers to what is known as the R-J speaker enclosure; the article deals firstly with the flat baffle, the open-back box, the closed box, horns, bass reflex, and then the R-J enclosure. The various responses of these are discussed. In pursuing the design of a small enclosure, an adaption of the Helmholtz resonator was decided upon. Such resonators are characterized by high Q, and the R-J design effects the control of Q to give a small but effective enclosure.

—Ibid., p. 19.

A zero impedance output stage: a series R-C circuit shunts the primary of the output transformer so that the output tube works into almost unity power factor load. This minimizes harmonic distortion and phase shift. A positive feedback control is adjusted so that the output tube presents zero impedance to its plate load. The circuitry and methods of adjustment are given, and the results are said to be particularly good.

—Ibid., p. 21.

Binaural or stereophonic? The author clarifies the meanings of the two words which have been used to describe the innovation. A distinction is made between the two systems. The first term means two-eared, which gives discrimination against unwanted sounds and gives the faculty of sound location; the second term means three-dimensional sound. The possibilities of these systems is explored and also of the mixed system "histereonauralphonic," which certainly sounds complicated.

—Ibid., p. 22.

ELECTRONIC DEVICES

The scanning electron microscope: the instrument was first proposed by Knoll in 1935; the electron spot is moved over the specimen and the intensity of the beam leaving the specimen is recorded. In later instruments, electron multipliers are used for the intensification of the electronic streams. As the specimen is scanned by the beam, there is no need for it to be unduly thin, and the scanning microscope lends itself to the examination of metal surfaces.

—Electronic Engineering (Eng.), Feb., 1953, p. 46.

A further article on the electron microscope—this in relation to a monitor for the power supply. The performance of the instrument depends largely upon the stability of the power supplies for the various lenses. The monitor can be switched from circuit to circuit, and comprises a balanced amplifier which maintains the instrument at a high level of operating perfection.

—Eletronics (U.S.A.), Jan., 1953, p. 124.

Ultrasonic drivers on soldering irons and solder pots produce a cavitation action that removes oxide film from aluminium, giving simultaneous cleaning and tinning without flux. Magnetostriction units provide convenient sources of power and enable robust assemblies to be built. A laminated element is excited at a half-wavelength resonance, and becomes self-driven by virtue of a pick-up coil at one end, so the device works rather like a buzzer with an amplifier to supply the power.

—Ibid., Dec., 1952, p. 103.

The exacting requirements of electrocardiography have led to the development of D.C. amplifiers of outstanding sensitivity and stability. The design is given for an amplifier for pH measurements. The principle upon which such an amplifier works is explained and the modern refinements of the instrument given, with the design mathematics.

—Electronic Engineering (Eng.), Feb., 1953, p. 74.

INSTRUMENTS AND TEST GEAR

How to use the modulated oscillator for lining up the set. This is written for the beginner who wishes to know the procedure. A note is given on the use of an ordinary meter as an output meter, which is most desirable, although not always available. The article explains where to start and the lining up of the R.F. and local oscillator units.

—Radio and Hobbies (Aust.), March, 1953, p. 91.

The design is given of a differential transformer gauge capable of giving a full-scale deflection for displacements of 0.0001 in. The gauge is a device wherein the movement of a coil or armature increases the electromagnetic coupling between two coils at the expense of two others. The primary coil is supplied with alternating current and very small movements of the armature upset the balance, so that very small movements can be detected. A full description is given with the circuitry of the amplifier.

—Electronic Engineering (Eng.), Feb., 1953, p. 66.

MATERIALS, VALVES, AND SUBSIDIARY TECHNIQUES

The paper describes a theoretical and experimental investigation of a special form of klystron which seems to have many important uses as a frequency modulated oscillator. Basically, it is a single-cavity, two-gap klystron with a floating drift tube between two gaps. By applying a separate voltage to the floating drift tube it is possible to produce frequency modulation by varying the transit angle.

—Proceedings of the I.R.E. (U.S.A.), Jan., 1953, p. 25.

The general transistor properties of small size and weight, low power and voltage suggest extensive application of transistors to pulse or switching systems or computers, etc. It is possible to devise simple regenerative circuits which perform waveform generation, level restoration, delay, storage, and counting. The properties and limitations of transistors are discussed.

—Bell System Technical Journal (U.S.A.), Nov., 1952, p. 1207.

Microstrip is a new system of microwave circuitry which has been developed by Federal Telecommunication Laboratories. The new system features the use of thin sheets of fibreglass reinforced low-loss plastic with a continuous film of copper laminated to one side. Appropriate parts of a similar film on the other side are removed to leave a design giving the desired characteristics. The benefits include disposing of heavy and bulky "plumbing" for microwave conduction waveguide joints, etc., and the resulting apparatus is very light and compact.

—Electrical Communication (U.S.A.), Dec., 1952, p. 251.

Most experimenters are familiar with the "breadboard" for setting up electronic apparatus. Ideas are given for inset panels sliding into a frame, the panels have holes for the individual sockets and larger components, and can be arranged in any desired order between permanent ground and plate voltage busbars. With a good stock of insert panels, complete circuits can be produced directly without laying out and drilling holes in the chassis.

—Electronics (U.S.A.), Jan., 1953, p. 126.

MATHEMATICS

One of the well-known uses of the grid-dip meter is as a calibrated source of R.F. in the resonant circuit method of measuring inductance and capacitance. If the capacitance of a condenser is accurately known, the inductance of a coil connected to it can be determined. It is possible to get accurate L and C standards for a matter of pennies. By a proper choice of standards, a range of L and C measurements can be made which will be all the amateur will require. Charts are given for easy computation from the apparatus.

QST (U.S.A.), Jan., 1953, p. 48.

The effects of radiation on resonant lines: two-wire transmission line calculations are made considerably more accurate by including the effect of line radiation. Problems are solved using graphs of theoretically-derived equations that have been verified experimentally.

—Electronics (U.S.A.), Jan., 1953, p. 133.

When a pulse or other signal is applied to a filter with limited bandwidth, the output is a distorted version of the input because some of the signal frequency components of the signal are attenuated. A bandwidth nomograph is given for pulse filter networks, which gives minimum bandwidth required for adequate transmission of a periodic rectangular pulse.

—Ibid., Dec., 1952, p. 142.

PROPAGATION

The article deals with the Pound-stabilized oscillators and their use in the measurement of the spatial variations of refractive index in the atmosphere. It has been shown that neighbouring pockets of air of about one litre can, under disturbed conditions, have widely differing indexes. The erratic variations resulting from air passing over a dish of water reveal one way in which pockets of different water vapour content can be formed.

Proceedings of the I.E.E. (Eng.), Part III, Jan., 1953, p. 19.

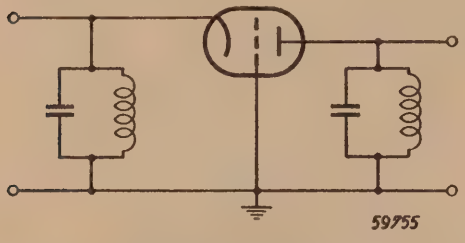
RECEIVERS

Noise performance in V.H.F. receivers: most modern receivers have sufficient gain for their performance to be limited by noise. The major causes of noise are: atmospheric noise due to lightning discharges, cosmic noise due to solar bodies, man-made noise from electrical equipment, and thermal noise in the aerial and receiver input circuits. At frequencies in the

(Concluded on Page 48.)

TUBE DATA: EC80, U.H.F. Triode for Grounded-Grid Circuits

The EC80 is an indirectly-heated triode designed for use at ultra high frequencies. As an amplifier the tube can be used up to 500 mc/sec. The amplification factor and the mutual conductance are high (μ = 80 and S = 12 mA/V), while the noise of the tube is very small. (Noise figure about 8 db. at 300 mc/sec. with a bandwidth of 4.5 mc/sec.) These properties make the EC80 suitable for a number of applications on decimetric waves, for example in Business or Citizens Radio, radio links, measuring equipment, etc., etc. Due to its high mutual conductance and low noise the EC80 will also be of great use in a number of applications at lower frequencies. We mention, for instance, broad-band amplifiers, I.F. stages following a crystal mixing stage, etc. The EC80 is especially intended for use as an amplifier and mixer in grounded-grid circuits. In these circuits the grid, instead of the cathode, is the common electrode of the input and output circuits. In Fig. 1 the basic diagram of a grounded-grid amplifier is shown; in such a circuit an appropriately constructed grid will act as a screen between anode and cathode, making a separate screen grid superfluous. In spite of the ultra high frequencies it will therefore be possible to use two triodes, instead of pentodes, in these circuits with good results.



Triode in grounded-grid circuit. The D.C. sources have been omitted.

Fig. 1.

Owing to the absence of the so-called partition noise, inherent in a pentode, the total noise of a triode is smaller than that of a pentode. This explains the favourable behaviour of the triode EC80 in grounded-grid circuits with respect to noise.

In order to reduce the effects of troublesome capacitances, self-inductances, and resistances, the measures described in the introduction have been taken. In this connection special attention may be drawn to the self-inductance of the grid lead. This lead being common to both the input and the output circuits, self-inductance will show a tendency to cause instability. In the case of the EC80 this has been avoided by connecting the grid to four pins in parallel. If the corresponding socket contacts are connected to earth the self-inductance of the grid lead and the tendency to instability will be reduced to a minimum.

Whereas the gain of a tube at lower frequencies is only slightly influenced by the input and output impedances of the tube, this is no longer the case on decimetric waves. Due to the influence of transit-time effects, resistance and self-inductance of the connecting leads, etc., these impedances are diminished in such a way that their influence on the gain becomes very great, and as a result, the control of amplifying tubes will require power. Therefore, instead of speaking in terms of voltage amplification, as normally is done at lower frequencies, we will have to take into consideration the power gain. The definition of this quantity is as follows:

The power gain of an amplifier is the optimum ratio between the output power and the power available at the input.

Electrode arrangement, electrode connections and maximum dimensions in mm (Noval base).

Fig. 2.

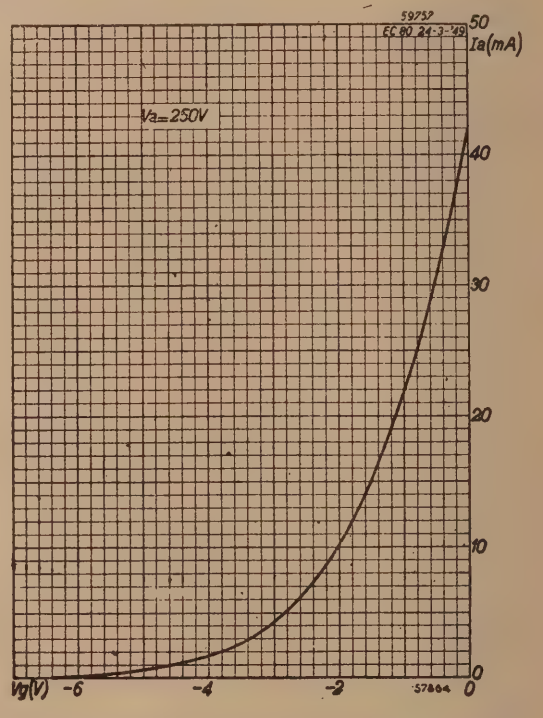


Fig. 3.—Grid voltage-plate current curve of the EC80 for a plate voltage of 250v.

As the power gain is dependent upon the width of the frequency band to be amplified, it is always necessary to mention the bandwidth of the amplifier. As a first approximation the product of power gain and bandwidth has a constant value, so that the gain at any bandwidth can be calculated if the gain at a certain bandwidth is known.

The noise of a receiver or an amplifier is defined by *the noise figure F, representing the noise-to-signal ratio*

at the output divided by the noise-to-signal ratio which is available at the input. Here both the noise and the signal are expressed as power, taken over the bandwidth of the amplifier, whilst the noise properties of the input power source are expressed in terms of a resistor at room temperature.

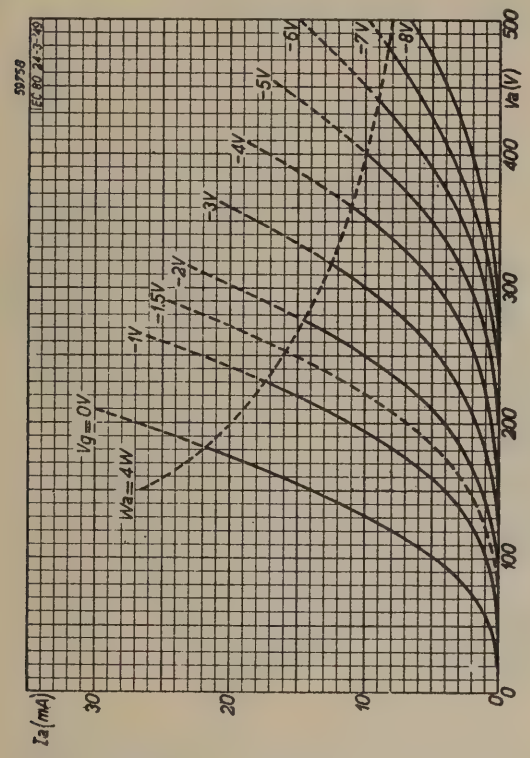


Fig. 4.—Plate current-plate voltage family for the EC80.

As may be seen from the operating data of the EC80 mentioned under Technical Data, the *power gain G* at a frequency of 300 mc/sec. and a bandwidth of 4.5 mc/sec. is about 15 db. and the *noise figure F* about 8 db. (see also Fig. 5).

TECHNICAL DATA

Heater Data

Heating: indirect with A.C. or D.C.; parallel supply

Heater voltage	V_f	= 6.3 V
Heater current	I_f	= 0.45 A

In order to obtain a stable functioning in grounded-grid circuits, the four grid contacts must be connected to earth.

Capacitances (measured with the tube cold).

Input capacitance	$C_g(_{k+f})$	= 5.4 pF
Output capacitance	C_{ag}	= 3.4 pF
Capacitance between anode and cathode + heater	$C_a(_{k+f})$	< 0.06 pF

Typical Characteristics

Anode voltage	V_a	= 250 V
Grid voltage	V_g	= —1.5 V
Anode current	I_a	= 15 mA
Mutual conductance	S	= 12 mA/V
Amplification factor	μ	= 80

Operating Characteristics

Power gain at 300 mc/sec. (bandwidth 4.5 mc/sec.)	G	= appr. 15 db
Noise figure at 300 mc/sec. (bandwidth 4.5 mc/sec.)	F	= appr. 8 db

Limiting Values

Anode voltage in cold condition	V_{ao}	= max. 550 V
Anode voltage	V_a	= max. 300 V
Anode dissipation	W_a	= max. 4 W
Cathode current	I_k	= max. 15 mA
Grid current start	V_g	
	($I_g = +0.3\mu A$)	= max. —1.3 V
External resistance between heater and cathode	R_{fk}	= max. 20 kΩ
Voltage between heater and cathode	V_{fk}	= max. 100 V

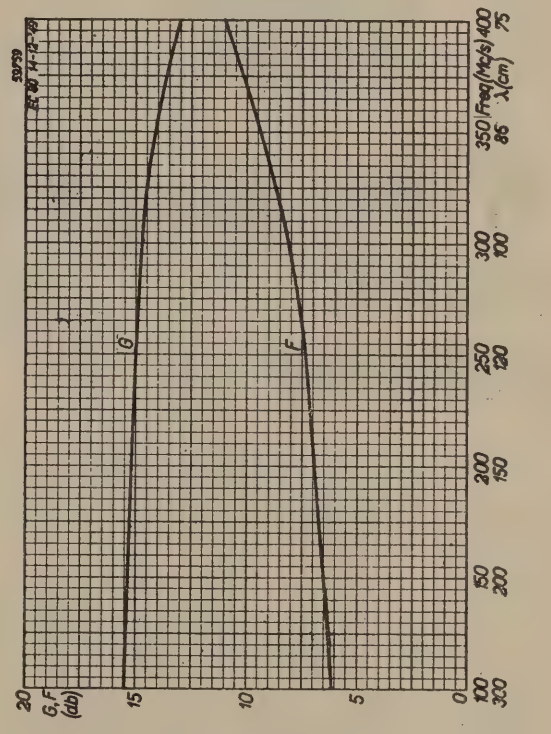


Fig. 5.—Graphs of power gain, G, and noise figure, F, for a grounded-grid amplifier stage employing the EC80, for frequencies between 100 and 400 mc/sec.

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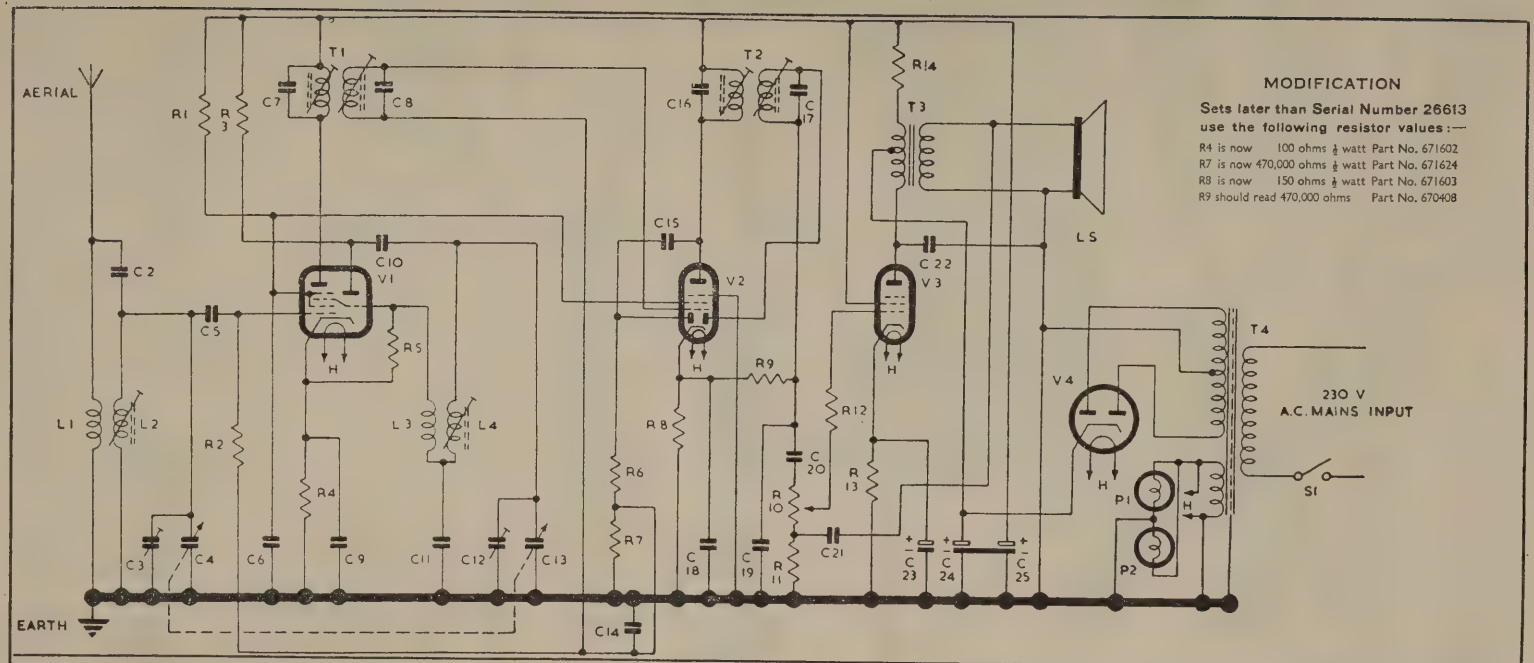

MODIFICATION

Sets later than Serial Number 26613 use the following resistor values:—

R4 is now 100 ohms ½ watt Part No. 671602
R7 is now 470,000 ohms ½ watt Part No. 671624
R8 is now 150 ohms ½ watt Part No. 671603
R9 should read 470,000 ohms Part No. 670408

circuit diagram of the PYE MODEL PZ43

fitting a new tuning scale

1. Remove Chassis
2. Place Scale Plate in cabinet aperture and screw clips tightly in position, first making sure that the scale is square with the cabinet aperture
3. Fit Chassis in cabinet
4. Adjust Gang Condenser to maximum position and make sure that the pointer lines up with the spot at the end of the track.

CONDENSERS

	Specification	Volts		Fig	No
C1	NOT USED				
C2	3-13 pF Ceramic		5%	3	666549
C3	4-50 pF Trimmer			3	800095
C4	528 pF Gang Condenser			1&2	800027
C5	100 pF Mica		20%	3	666520
C6	0·1 μF Tubular	350		3	668603
C7*	100 pF Mica		2%	1&2	666776
C8*	100 pF Mica		2%	1&2	666776
C9	0·1 μF Tubular	350		3	668603
C10	100 pF Ceramic		20%	3	666520
C11	560 pF Mica		2%	3	666272
C12	4-50 pF Trimmer			3	800095
C13	528 pF Gang Condenser			1&2	800027
C14	0·02 μF Tubular	150		3	669105
C15	10 pF Ceramic		20%	3	666525
C16*	100 pF Mica		2%	1&2	666776
C17*	100 pF Mica		2%	1&2	666776
C18	0·1 μF Tubular	350		3	668603
C19	470 pF Ceramic		20%	3	666521
C20	0·005 μF Tubular	150		3	669081
C21	0·1 μF Tubular	350		3	668603
C22	0·01 μF Tubular	600AC		1&2	668839
C23	25 μF Electrolytic	12		3	667170
C24	16+16 μF Electrolytic	350		3	667509
C25					

RESISTORS

	Ohms	Watts		Fig	No.
R1	6,000	½	10%	3	670456
R2	2·2 meg.	½	20%	3	670412
R3	33,000	½	20%	3	670401
R4	220	½	20%	3	670388
R5	47,000	½	20%	3	670402
R6	2·7 meg.	½	20%	3	670412
R7	†0 meg.	½	20%	3	670410
R8	470	½	20%	3	670408
R9	470	½	20%	3	670408
R10	500,000 Potentiometer		20%	3	610221
R11	6,800	½	20%	3	670397
R12	100,000	½	20%	3	670404
R13	150	1	10%	3	670508
R14	1,500	1	5%	3	670694

Note:— * Integral part of I.F. Transformer.

INDUCTANCES

	Specification	Ref.	Fig.	No
L1	M.W. Aerial Coil	MW7A	3	780246
L2				
L3	M.W. Osc. Coil	MW9A	3	780254
L4				
LS.	Loudspeaker		1	850019

TRANSFORMERS

	Specification	Fig.	No.
T1	1st I.F. Trans. {Prim. 12·2 Ω, Sec. 12·2 Ω}	1&2	770369
T2	2nd I.F. Trans. {Prim. 12·2 Ω, Sec. 12·2 Ω}	1&2	770369
T3	Output Trans. {Prim. 480 Ω, Sec. —}	2	770397
T4	Mains Trans. {Prim. 56 Ω, Sec. 160+170 Ω}	1&2	770807

SWITCHES, LAMPS, ETC.

	Specification	Fig.	No.
S1	Mains On/Off Switch on Volume Control	3	810221
P1	Dial Lamp 6·5V., 0·3 amp	2	700497
P2	Dial Lamp 6·5V., 0·3 amp	2	700497

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The "R. and E." Synch. Signal Generator—Part IV

By W. D. FOSTER

Part III of this series, in last month's issue, described the circuits of the pulse generator for the line blanking pulses, and also the procedure for setting up the whole circuit as far as V_5, using the oscilloscope. In this issue, we go on to describe the delay circuit and pulse generator which makes the line synchronizing pulses.

TIME DELAY FOR THE SYNCH. PULSES

In Fig. 4 (c) we showed the output waveform of V_{5b}, which, on the circuit diagram of Fig. 2 is labelled "Line Blanking Out." The pulse generator comprising V_{5a} and V_{5b}, it will be remembered, is triggered directly by the divider, V_4, which provides the line-frequency square-wave from the master oscillator's frequency of 20,250 c/sec. Some readers might wonder why it is that we have called V_5 the generator of the line blanking pulses, rather than of the line synchronizing pulses. The answer to this question is to be found in the waveform diagram of Fig. 1. Here, a reference to the detailed structure of the television waveform will show that in order for the receiver circuits to get ready for the line synch. pulse, the cathode ray tube is blanked out for about half a microsecond before the pulse occurs. Thus, the horizontal blanking pulse is not only longer in duration than the synch. pulse by some 6.5 μsec., but also it starts 0.5 μsec before the synch. pulse. Therefore, if we make the start of the blanking pulse coincide (as we have done) with a fixed reference point in time, then steps must be taken to ensure that the line synch. pulse does not start until the statutory 0.5 μsec. after this same reference point. For this reason, the start of the line blanking pulse is taken as the fixed reference point, and a circuit is introduced which delays the formation of the synch. pulse for the requisite small half-microsecond period.

This function is performed by V_6 and its associated circuit. V_7 and V_8 form a further pulse generator, very similar to that of V_5, but not quite, because it is triggered in the same way as V_4—that is, it has to be triggered by a negative voltage step, just as V_4 has to be, and so the same diode triggering circuit is used as before.

The delay valve, V_6, is nothing more than an amplifier stage, driven on the grid by the square-wave output of V_4. Since this output is a wave with a peak-to-peak amplitude of about 60 volts, V_6 is what is known in TV and radar circles as overdriven—that is to say, it is not a Class A amplifier, but has its grid driven beyond cut-off on the negative half-cycles of the input wave, and into grid current on the positive half-cycles. It has a large grid leak, of 500k., and a large input condenser of 0.02 μf.—large, that is, in relation to the time of one cycle of the input waveform. As a result, the square-wave is faithfully reproduced at the upper end of the 500k. grid leak resistor. If the 20k. resistor connected between this point and the grid of the valve were omitted, all that V_6 would do would be to reverse the polarity of the input waveform. But, in practice, we have in the grid circuit what is known as an integrating circuit. Unfortunately, only half of this shows on the diagram, because the other half is inherent in the valve itself, in the shape of its input capacity. Thus, the circuit really consists of the 20k. resistor, together with a small condenser, connected from the grid pin to earth. This is the so-called integrating circuit, and its action is illustrated in Fig. 5.

At (a) in this figure, we have the waveform at the plate of V_{4b}, and this drawing, too, can be taken to represent the waveform at the junction of the 500k. and the 50k. resistors in the grid circuit of V_6. At (b), however, is shown the waveform at the grid of V_6. It will be seen that the nice straight vertical jumps are no longer that way, but have become partially rounded off. The way in which this action takes place is as follows: The voltage at the grid attempts to rise as quickly as does the input waveform, but is unable to, because of the capacity from grid to earth. This capacity has to be charged up, through the 20k. resistor, before the grid can reach its most positive potential. It does so exponentially, and this accounts for the curved rise in voltage at the grid, where we can see that it is not until after an appreciable fraction of the cycle that the grid reaches its maximum positive potential. There it stays until the next negative voltage jump occurs. But this, too, cannot take place instantaneously, because this time the condenser formed by the input capacity of the

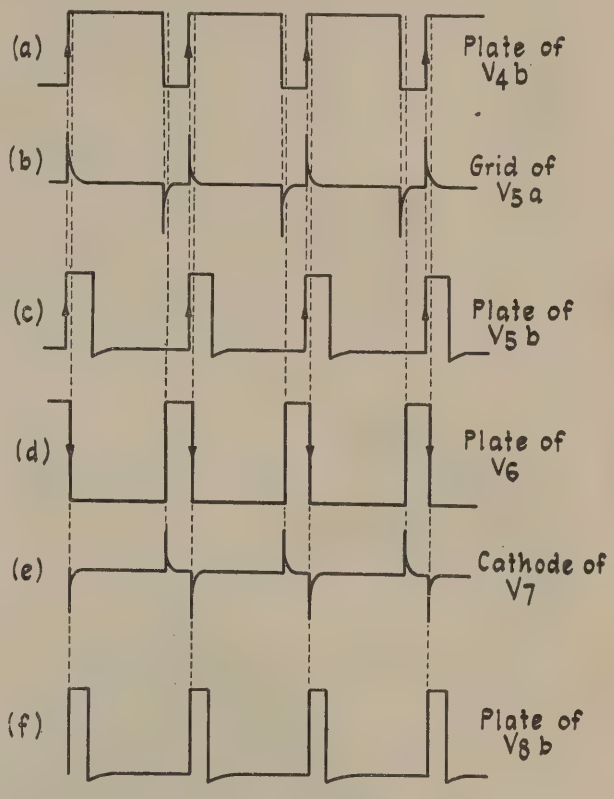

Fig. 4

tube is charged, and the potential of the grid cannot fall to its lowest value any faster than the condenser can discharge itself. As a result, the negative jump is distorted, too, and the waveform degenerates into that of Fig. 5 (b). We cannot readily alter the input capacity of the valve, but we can easily control the value of the grid-stopper resistor. If we do this, we can make the rounding-off of the waveform more pronounced by increasing it, or less so by decreasing it.

Now, when an overdriven amplifier is provided with a rounded waveform at the grid, we can say with reasonable accuracy that the voltage jumps which occur in the plate circuit coincide with the times at which the input waveform crosses the grid-base of the valve. Now, with a perfect square-wave, the jumps are instantaneous, and the waveform passes through cut-off and the grid-current point simultaneously. But in practice the jumps always take a certain small length of time, and the duration of the voltage jumps in the plate circuit corresponds with the time taken by the input waveform to cross from cut-off to grid current. With fast waveforms such as we are interested in here, this time will be only a very small fraction of a microsecond. If, however, by the use of an integrating circuit such as we have just described, the input waveform is given a definite slope as it crosses the grid base of the valve, the voltage jumps in the plate circuit will take place a fraction of a microsecond after the corresponding jumps on the input waveform to the integrating circuit. As a result of all this,

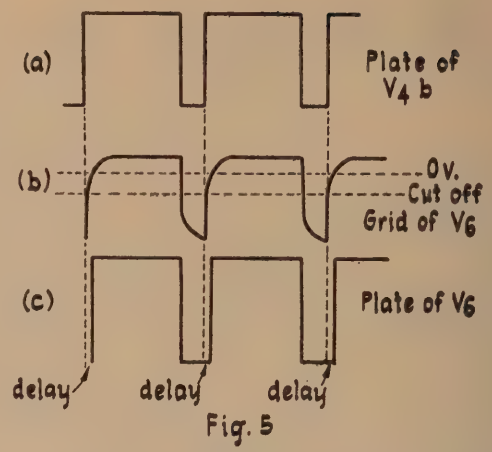

Fig. 5

we can produce small delays in the time of occurrence of a voltage jump by purposely rounding off the input waveform and then squaring it up again by means of an overdriven amplifier, or "squaring stage" as it is more often called. The more we round off the input waveform, the longer will be the delay.

This method is very simple and straightforward, and is very suitable in cases where very small delays are required. For larger delays, amounting to a large fraction of the time of one cycle, other methods have to be used. In Fig. 5 (c), we have drawn the plate *current* waveform of V_6, illustrating roughly how the jumps in plate current are delayed by the rounding-off of the grid voltage. This, of course, is the primary effect. The actual output of the valve consists of the plate *voltage* waveform, which is the same as Fig. 5 (c), only inverted. This merely signifies that the overdriven amplifier stage, as well as producing the delay, causes the usual 180 deg. reversal of the input signal, whether we like it or not.

Because of this, the square-wave output of V_8 is both delayed by approximately 0.5 μsec., and reversed in phase, compared with the original waveform at the plate of V_{4b}. The timing of the blanking pulse which is the output of V_5, it will be remembered, is tied to the positive voltage jumps at the plate of V_{8b}. For the synch. pulse that V_8 is to produce, the essential timing jump is negative, on account of the phase reversal in V_8. Consequently, V_7 is used to trigger V_8 from the negative-going pips of the short CR circuit, just as was done in triggering V_4. The same 50 $\mu\mu$f. and 20k. short CR circuit is used ahead of the diode as before, and triggering takes place at the grid of V_{8b}. The circuit of V_8 is identical with that of V_5 in every respect. Even the time constant of V_{8b} grid circuit is the same, but the reason is not far to seek. It will be remembered that the variable cathode resistor gives a very wide control over the time-duration of the output pulse from the flip-flop. Well, the only essential difference between the pulses used for line-blanking and line-synchronizing is that the former lasts for 16.5 μsec., while the latter lasts for only 10 μsec. This difference is negligible compared with the range of control provided by the variable cathode resistors, so that the same circuit values are quite satisfactory.

NEXT CIRCUITS TO BE PROVIDED

The eight valves so far used have produced two of the basic waveforms needed. The remaining ones are the

vertical blanking pulses and the vertical synchronizing pulse trains. The latter, consisting of a series of long pulses, at twice the line frequency, are responsible for a large proportion of the circuits in the completed signal generator, and account for the bulk of the complication. The production of the vertical blanking pulses is no different in principle from that of the horizontal ones, and, indeed, we have already used all the types of individual circuit that will be required for making the frame blanking pulses. For example, it is true that we will need a string of frequency dividers, in order to derive the frame frequency of 50 c/sec. from the master oscillator frequency of 20,250 c/sec. But these dividers can all have exactly the same type of circuit as the divider of V_4. The only thing that need be different is the time-constant of the grid circuit. In each divider, whether it divides by three or by five, this time-constant is adjusted until the correct number of triggering pulses is "skipped" during the unstable period after triggering has taken place. Altogether, there will be five divider stages, dividing respectively by 3, 3, 3, 3, and 5—a toal of 405 times, and equal to the number of lines per complete picture. Immediately following the dividers will come a further pulse generator, similar in all respects to V_5, but with a grid circuit time-constant long enough to make the positive-going output pulse last for the duration of 14 lines, or approximately 1380 μsec.

For the rest of the functions, there will be needed another pulse, also at frame frequency, but with a dura-

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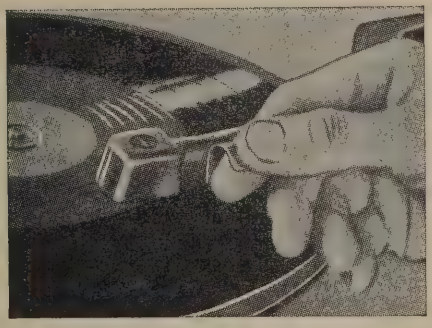

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tion of only four lines. This will be used as a keying waveform, and will be used to select eight of the 20,250 c/sec. pulses that are used as the frame synch. pulse train. It is also used in mixing these with the line pulses in order to produce the composite synch. signal, containing both line and frame synch. signals at once. This pulse (i.e., the frame-frequency pulse of four lines' duration) can start at the same time as one of the line-blanking pulses, and also at the same time as each frame blanking pulse, so that it can be generated directly from the last frequency divider, which will have a voltage jump coinciding exactly in time with the line blanking pulses at the plate of V_{5b}.

Then we must have the pulses at twice line frequency, which are used for the frame pulse train. These will be made from the master oscillator directly, since its frequency is correct, but there will have to be a delay circuit, similar to that of V_6, interposed between the plate of V_2 and the pulse generator. This is because the leading edges of the 20,250 c/sec. pulses are required to coincide with that of the line synch. pulses. The delay, therefore, will have to be exactly the same as is obtained with V_6. It can be seen, therefore, that, although the complete signal generator contains quite a large number of circuits, we have so designed it that the number of circuit types is very small. This has several desirable effects. In the first place, it makes the circuit operation easy to understand; by the same token, it makes it so much the more straightforward to adjust. Then again, it enables very few tube types to be used, which is a useful thing whether or not the generator is put into everyday service. If it is, the range of spare valves it will be necessary to carry in stock will be quite small.

The circuits so far described complete those needed in order to give the basic waveforms. For the rest, all we will have will be a few pulse-mixing circuits, so as to make the right composite waveforms from the individual ones. For example, the frame and line blanking pulses will be mixed and clipped in order to get rid of some of the small waveform irregularities which occur in the individual waveforms. We then have a composite blanking waveform, suitable for use in a camera, a monoscope, or any other source of picture signals. Then there is the mixer circuit for forming the train of frame pulses, and that for mixing this, once made, with the line pulses,

(To be continued.)

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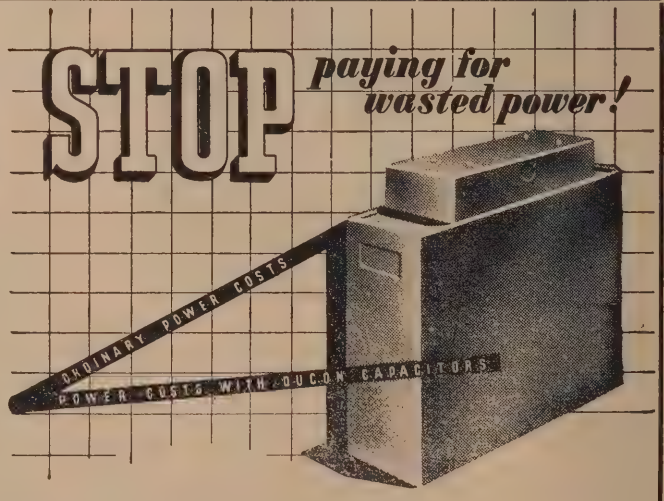

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TV News of the World

Closed Circuit Colour Television—U.S.A.

It is expected that in six months closed circuit colour television clinics on cancer will be "fed" to 19 cities by C.B.S. with the American Cancer Society underwriting the 250,000 dollar project designed to educate doctors in detecting and treating the disease. Officials hope to reach most of the 55,000 doctors (of the nation's 157,000) located in the 19 cities.

The project is under the direction of the C.B.S. laboratories.

Television Set Using Transistors

During November, 1952, R.C.A. demonstrated a complete experimental portable television receiver operating without any radio tubes.

All the radio tubes' functions were carried out by the use of 37 "transistors."

The television receiver was battery operated and about one-quarter of the weight and size of the ordinary home table model set.

Dr. Engstrom, vice-president of the R.C.A. laboratories division stated: "We have seen more progress in four years of transistor development in the laboratory than in twenty for the radio tube."

Television Receiving Licences—Great Britain

The number of television licences issued in Great Britain up to the end of July totalled 1,564,254.

Television Set Sales—Canada

The total number of television sets sold in Canada for the month of September, 1952, was 19,241 sets, with a retail value of 8,629,781 dollars.

Sales for the nine months of 1952 totalled 70,209 valued at 32,016,790 dollars.

Television Sets Exported from the U.S.A.

Television sets exported for the 30 weeks of 1952 totalled 41,185 sets.

The breakdown of this export figure being as follows: 22,742 to Cuba; 8,240 to Argentine; 5,545 to Brazil; 1,946 to Mexico; 18 to Italy.

Radio sets exported during the same period totalled 175,339 sets.

Industrial Television—Commercial Model

R.C.A. recently announced the release of its first commercial model of its industrial closed circuit television system, using the Vidicon tube.

The camera uses only three tubes, including the Vidicon and the entire system, consisting of two units, uses 22 tubes.

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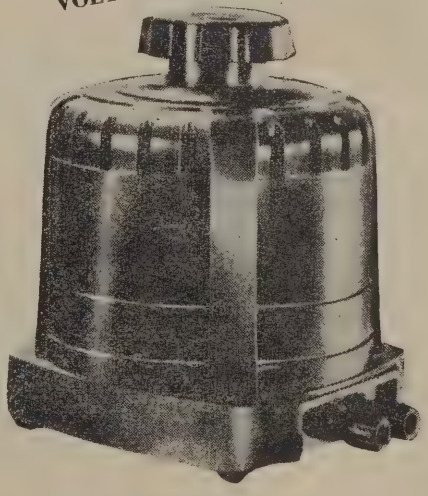

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THE EDITOR'S OPINION

A New Viscous-damped Pick-up Arm

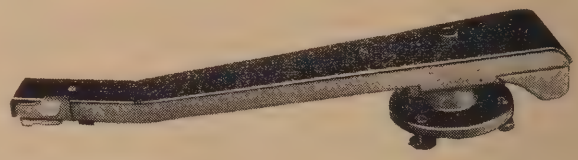
It has for long been recognized by professional men that in the reproduction of gramophone records the use of a good pick-up head is by no means the whole story where excellence of the results is all-important. In fact, a head is often completely spoiled by mounting it on a poor arm, since the arm can make or mar the results obtained. Accordingly, it is very pleasing to find a New Zealand firm producing a pick-up arm built to the highest standards of design and manufacture, and worthy of the best reproducing heads. This is the viscous-damped arm produced by Telecommunications Ltd., of 27 Lower Tory Street, Wellington. It is of such novel design, and is so effective in achieving what it sets out to do, that a description of it will not fail to interest a great many of our readers.

DAMPING APPLIED TO PICK-UP ARMS

Practically all arms to be found do not employ any sort of damping of their movement. They are designed to pivot as freely as possible in both vertical and horizontal planes, on the principle that there must be no constraint at all placed on the movement of the head as a whole. But the output of the head depends on movement of the stylus and its associated parts relative to the rest of the head, so that, in a freely-mounted arm, it is only the latter's inertia which prevents the whole arm from vibrating in response to the modulation of the record's grooves. Unfortunately, however, any arm has a number of frequencies at which a natural vibration occurs, and should one of these resonant frequencies come within the audio range, the resonance will overcome the inertia of the arm, which will vibrate strongly at that frequency. This has a profound effect on the reproduction, since arm resonances increase the electrical output at their own frequencies and at frequencies considerably removed from these. It is natural, then, that pick-up designers go to considerable lengths to ensure that arm resonances are either very small or else occur at such low frequencies that they have no effect on the electrical output of the head. In order for this last condition to be met, the main resonance of the arm should occur considerably lower than 20 c/sec., and this is a very difficult condition to meet in practice.

Even when such a specification is met, however, a freely-pivoted arm has certain disadvantages. It can be dropped accidentally on the turntable, with disastrous results to both pick-up head and record! The introduction of mechanical or other damping into the up-and-down movement of the head can remove this danger altogether, and, at the same time, it can remove altogether the main arm resonance, with exceedingly beneficial effects on both reproduction and record wear. Unfortunately, a freely-moving mechanical system which is heavily damped is a very difficult thing to design in the ordinary way, for a variety of reasons. The "Teleco" pick-up arm solves the problem in a very simple and elegant manner. Basically, it consists of a fairly conventional arm, mounted in a quite unusual way. Instead of having plain or ball-bearings at right-angles, in order to provide for the movement of the head in any direction, the suspension consists of a needle-point sitting in a conical depression in a fixed post, much after the manner of a bearing at one end of the shaft of a gear-wheel in a watch or clock. In order that this single pivot will support the arm without the possibility of its falling off the post, the centre of gravity of the whole arm is arranged to be lower than the pivot point. It is then possible to balance the arm so that it rests in a perfectly horizontal position.

On its own, this system would represent the ultimate in freely-pivoted arms, but would be quite unusable, since a light touch would be sufficient to knock the arm from its supporting post. This is where the viscous damping comes in. Attached to the supporting post is a metal cup, hemispherical in shape, while attached to the arm is a metal part, almost hemispherical in shape, which, when the arm is in position, almost—but not quite—touches the cup. The space between the ball and cup is filled



with a special grease of exceedingly high viscosity, and it is this alone which provides the damping and which prevents the arm and supporting post from coming apart. In case this should sound like a tall story, it should be pointed out that the grease used has a much greater viscosity than even the heaviest lubricating grease. Indeed, so sticky is it, that when the damping is adjusted to be a maximum, and the arm is held as high as it will go, and then dropped, the pick-up head takes about nine seconds to fall to the surface of the record! It can thus be seen that there is not the slightest possibility of damaging either the stylus or the record should the pick-up be released accidentally. On the upper surface of the arm is a screw adjustment which enables the distance between the cup and ball to be varied, so that the degree of damping actually used is under the control of the operator.

FURTHER ADVANTAGES OF VISCOUS DAMPING

It might be thought that material like the viscous grease would prevent the pick-up from moving freely across the record in response to the travel of the groove, but this is not so. With this sort of damping, the counter-force exerted by the viscous material is proportional to the speed with which the arm is moved. When in use, the rate of movement across the record is so small that the retarding force exerted by the damping material is virtually zero, so that, for movement in this direction, the effect is just as if the grease were not there, and there is no side drag at all on the stylus.

Unfortunately, however, not all gramophone records are perfect, and a pick-up is often faced with the problem of playing a record which is warped or which has a spindle-hole slightly off-centre. Under these conditions, forces are applied to the stylus which tend to cause it to ride upwards, and leave the groove. These movements are very much more rapid than the normal movements of the head, so that when a warped record is being

played the damping effect of the grease once more comes into play and exerts a counter-force which prevents the stylus from leaving the groove. It is no exaggeration to say that a viscous-damped arm can play perfectly through records that are so warped that no other type of arm will alow the pick-up to stay in the groove.

THE ARM ITSELF

The photograph opposite gives some idea of the construction of the "Teleco" arm. It is a transcription arm, measuring 11¼in. from pivot to stylus point, and with the last few inches offset at the proper angle to reduce the tracking error to very small proportions. The counterbalance weight extends 3 in. behind the pivot, so that a space approximately 14 in. from the centre of the turntable is needed in which to mount the arm.

At the moment it is available only for use with G.E. variable reluctance heads, and is supplied complete with two slides, which have the heads screwed to them, and which make the heads into plug-in units, one for 78 records and the other for microgroove ones. There are special weights supplied as part of the slides, so that the weight on the stylus point shall be 19 grammes for the 78 head and 5 grammes for the L/P one. The heavy cast base is provided with three hollow adjusting screws which enable the position of the arm to be adjusted for both height above the motor-board and for levelling. The mounting screws or bolts pass through these screws. The arms are supplied without the damping medium, which is provided in a metal tube, and must be inserted by the user on installation. The reason for this is that if the arms were packed with the damping grease in position, it could slowly leak away if the arm were not standing upright. However, when the arm is in use, there is no possibility of loss of the damping material.

Needless to say, the unit will not be exactly inexpensive, but when it is considered that it is probably as good an arm as could be purchased anywhere in the world, the matter of price can hardly be regarded as a major consideration. The cost of L/P records being what it is, it would not take many damaged records to make up the arm's initial cost. For those who want the absolute best in their reproducing equipment, this arm will undoubtedly be a "must."

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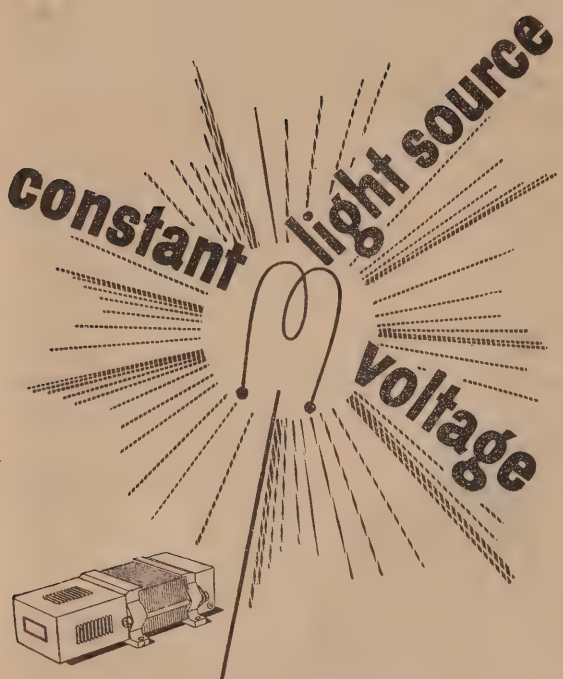

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TRADE WINDS

A recent visitor to our shores—albeit only a fleeting one—is Mr. G. J. Jenneskens, the director of the Electronic Division of the wide-flung Philips "commonwealth." Although he was in Wellington only two days and in Auckland one, he left behind him a few thoughts of a most refreshing nature. His dynamic personality, his great frankness, and, above all, his utter conviction of the vast future of the electronic art, left a very strong impression on those who were privileged to meet him.

Mr. Jenneskens was particularly interesting when he touched on the probable effects on electronic developments of the new so-called black ceramics (ferroxcube and ferroxdure), transistors, and printed circuitry. He believes that these recent developments are the forerunner of new electronic conceptions which necessitate a new technical approach to many problems at present incompletely solved by vacuum tube technique. His comments on the present stage of development of transistors, of the great difficulties associated with their mass production, and the enormous research effort going into the problems and applications they create were very interesting indeed. But more surprising still were his comments on the philosophy of the Philips research laboratories throughout the world. It is only such large firms as Philips that can support the enormous research enterprises which give us all the electronic tools of today and tomorrow. That being the case, says Mr. Jenneskens, it becomes an obligation and the duty of such powerful research organizations to make available to everyone concerned the fullest amount of technical information, and to do so unreservedly and quickly. He believes that by doing this and in instituting electronic application laboratories for the benefit of all, the whole industry must gain, and that by helping the weak to become strong and the strong stronger the electronic art must become immeasurably larger. He expressed pleased surprise to find so much electronic activity already apparent in the New Zealand radio industry, but, even so, he felt we could do a lot more to expand our capacity to undertake more of it, both in quantity and complexity. It needs highly trained and skilled personnel, said Mr. Jenneskens, and we should see to it that we get them and keep them.

He does not see any good reason why this country should not have television—in fact, it is a must if only as a stepping-stone for the training of engineers and technicians for the greater electronic problems of the future. Nowadays, no country is any stronger than its electronic capacity will allow it to be, is his firm conviction.

We all have a high regard for the type and quantity of technical information so freely made available to us by the local Philips organization, but Mr. Jenneskens made us smile when he considered that at present it was only a small trickle of what we could expect in the years to come.

He has obviously left some headaches for our local Philips friends.

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"Rubber in Chemical Engineering": British Rubber Development Board, London. (L. V. Phillips, Lower Hutt.)

"Jenolite News," Vol. 4, No. 7: Jenolite, Ltd. (H. A. Parton, Ltd., Wellington.)

"Philips Bulletin," January, February, March, 1953. (Philips Electrical Industries of N.Z. Ltd., Wellington.)

"Marconi 1953 Catalogue": Marconi's Wireless Telegraph Co. Ltd., Chelmsford, Essex, England. (Amalgamated Wireless Australasia Ltd., Wellington.)

"The Strowager Journal": Automatic Telephone and Electric Co., Ltd., Liverpool.

"Aerial," January, 1953: Marconi's Wireless Telegraph Co. Ltd., England. (Amalgamated Wireless Australasia Co. Ltd., Wellington.)

"Radiotronics," Vol. 18, No. 3, March, 1953: Amalgamated Wireless Valve Co. Ltd., Australia.

"G.E.C. Telecommunications," November, 1952: British General Electric Co. Ltd.

"Enterprise," No. 23, March, 1953: Cory-Wright & Salmon Ltd., Wellington.

"A.P.A.E. Journal," Vol. 4, No. 2, February, 1953: Association of Public Address Engineers, England.

"Machinery Lloyd," Vol. XXV, No. 3, January, 1953.

January and February, 1953, Bulletins of the Centre de Documentacion Cientificia y Tecnica, Mexico.

"Principles of Television Servicing": Carter V. Rabinoff and Magdalena E. Walbrecht. (McGraw Hill Book Publishing Co. Ltd., London.)

"Principles of Radar": J. Francis Reintjes and Godfrey T. Coate: 3rd edition. (McGraw Hill Book Publishing Co., London.)

"Electronic Measurements," 2nd edition: Terman and Pettit. (McGraw Hill Book Publishing Co. Ltd., London.)

"Electronic Measuring," Vol. 3, No. 9: Philips Electrical Industries of N.Z. Ltd.

"Electronic Application Bulletin," Vol. 13, No. 8/9, Aug.-Sept., 1952: N. V. Philips Gloeilampenfabrieken, Eindhoven, The Netherlands. (Philips Electrical Industries of N.Z. Ltd.)

Missing and Stolen Radios

Criminal Investigation Branch, Wellington

Antone cream plastic portable, Serial No. 3182. Size 12 in. x 8 in. x 6 in. Plastic carrying handle on top; speaker grating above two brown plastic tuning knobs in front.

Unidyne Model 556A broadcast, Serial No. C5264. Oval head, radiator type grille of silver cast metal, 7½ in. base.

Earphones, usual type, unknown make, double steel head-band, two-prong jack on cotton covered telephone cable.

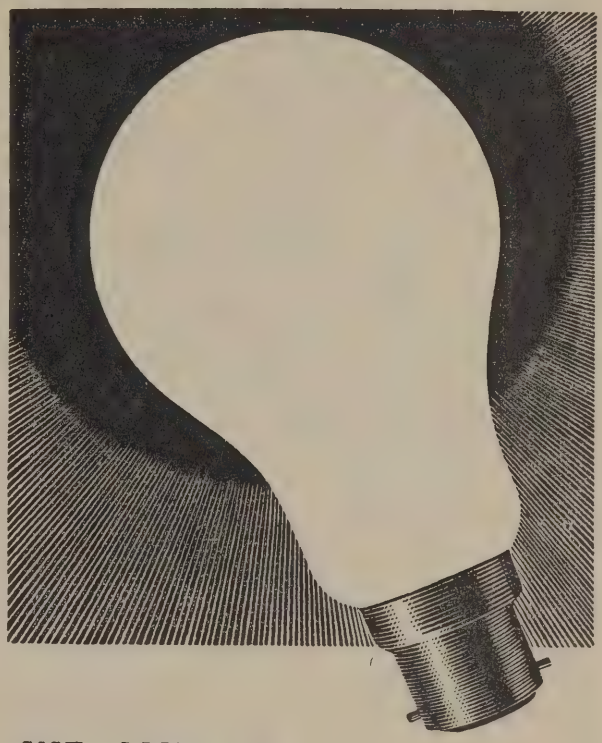
Hunt Condenser Checker (or capacitor) 8 in. x 10 in. x 6 in. in black box with dial in centre.

Police Station, Lower Hutt

Ultimate portable 6-valve radio, Serial No. 128398.

Criminal Investigation Branch, Christchurch

Pilot 4-valve mantel model, dual-wave radio, Serial No. 93261. Brown stained wooden case, 20 in. x 10 in.



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SWAN ELECTRIC COMPANY LIMITED

Auckland
Wellington
Christchurch

Criminal Investigation Branch, Napier

Ultimate battery-electric portable, Serial Nos. F.C. 73614 and G.15251. Light brown plywood case 18 in. x 12 in. x 9 in., carrying handle on top. Speaker covered with lighter brown material.

Police Station, Waiuku

Columbus Model 26, 5-valve Exeter, Serial Nos. 24205, stock No. 328.

The following radios have been recovered:
Pacemaker Serial No. 98571.
Pacemaker portable, Serial No. 97932.

Philips Experimenter

(Continued from page 25.)

Having adjusted the oscillator coil, the signal is fed directly to the grid of the R.F. amplifier tube, through a blocking condenser, so as not to short-circuit the A.V.C., and the gang is set to its highest frequency. The signal generator is tuned until the signal is received, and the trimmer C_{10} is peaked for best response. If it is not possible to hit the maximum, the likelihood is that the coil inductance is not quite correct. If the coils have been wound exactly according to specifications, it is not likely that the inductance is too high; rather will it be on the low side. In order to increase it, it is necessary to fit iron-dust slugs into the coil former. These slugs can be taken from old iron-cored coils or I.F. transformers. They are usually a little less than $\frac{1}{4}$ in. in diameter and a bit over this in length. In order to place them inside the much wider coil formers, they are wrapped with a piece of paper which has been folded into a strip containing several thicknesses, and about $\frac{3}{4}$ in. by $1\frac{1}{2}$ in. long. This is folded across one end of the slug and up parallel with the sides. The whole thing is then slid into the open end of the former just far enough to give the required increase in inductance. It is then fixed in position by flowing some polystyrene dope over slug and paper, so that the dope, on setting, holds the slug and the paper together, and both to the inside of the coil former. With the inductance correctly adjusted, the trimmers C_1 and C_{10} should be approximately two-thirds of the way in when tuning the coil to the high-frequency end of the band. If this adjustment is found, it will be found, too, that at the low-frequency end the tuning is so nearly correct as not to matter. The reason for this convenient behaviour is that the band is such a narrow one that three-point tracking is unnecessary.

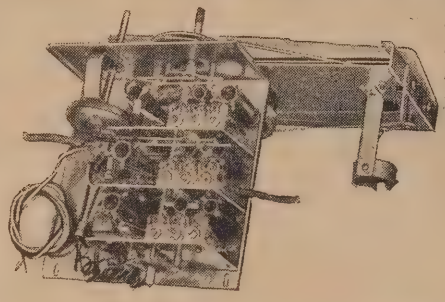
For adjusting the 40-metre coils, the oscillator range must be from 7455 to 7855 kc/sec. In this case, there is no need to adjust the inductance to the coils at all. The high-frequency end is set up with the parallel trimmer, C_{23}, after which the low-frequency end is set right with the series trimmer, C_{18}. It may need a little juggling to achieve just the right coverage, but this is only a matter of successive adjustments of the high and low-frequency ends, making sure that only the trimmers mentioned are touched at their respective ends of the range.

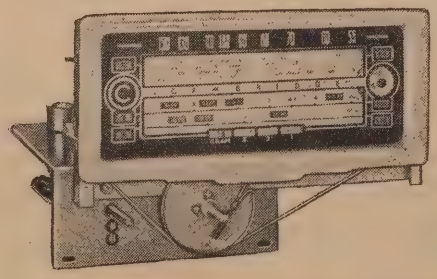
The 40-metre signal circuits are adjusted in much the same way, with the parallel trimmers adjusted at the high-frequency end, and the series ones at the low-frequency end. When both ends are right, the frequencies in between will also be correct, automatically.

The next and final instalment of this series will describe the setting-up of the B.F.O. and modulation circuits, and will have something to say about suitable power supply systems for the mobile station. Also, if space permits, we will give a few tips on mobile aerials.

(To be concluded.)

A PROBLEM SOLVED!





It's always a problem to obtain an all-wave coil unit together with matching dial and gang. Your worries are now over. We offer you the latest CAMBRIDGE All-wave Tuner Unit. This is a single assembly consisting of:

- **Coil banks wired and tested, tuning 3.5 to 20 mcs. and B/C band.**
- **R.F. and Mixer sockets mounted and wired.**
- **Band and Gram Indicator.**
- **Spin tuning and attractive three-colour dial assembly.**
- **All leads colour coded.**

Soundly designed, factory built, and with a really commercial appearance, the new Cambridge Tuner has everything.

Complete unit (as illustrated) and circuit diagram, £11/10/-

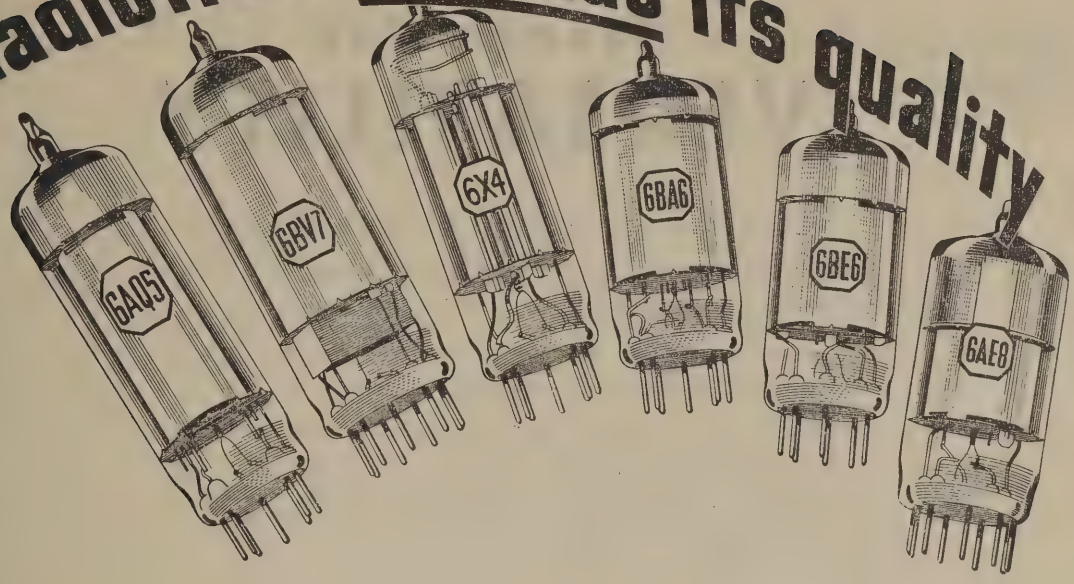
Cadmium-plated steel chassis to match, 23s.

Trade inquiries invited Obtainable only from

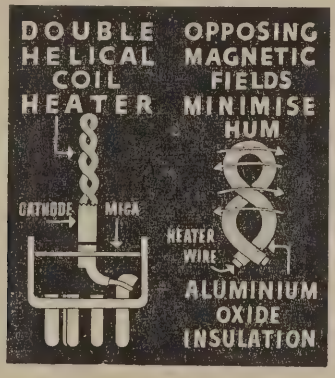
WEBB'S RADIOS LTD.

11 WELLESLEY STREET E., AUCKLAND

Radiotron in-builds its quality



The ability of Radiotron Valves to function at the high standard for which they are designed, is not left to chance—each minute part, each process in the assembly of Radiotrons is tested and checked to ensure that the finished product will stand up to the ultimate test of first-class performance.



By the use of the DOUBLE HELICAL COIL HEATER, hum level is greatly reduced. This feature has made possible the design of amplifier valves of greatly increased sensitivity.

The coil heater (shaded part) is designed so that the heater current flows in one circular direction to the top of the heater and in a reverse circular direction to the bottom, thus setting up opposing magnetic fields which effectively neutralize each other

Though it adds to the complexity of manufacture, the double helical coil heater is incorporated in the design of all Radiotron high-gain tubes of the 6.3 volt 0.3 ampere heater type intended for audio use.

AWV

RADIOTRON

VALVES

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Stands for
VERSATILITY

We suppose it is natural, but when a radio man thinks of transformers (if he does at all), it is small-power supply and audio components that immediately spring to mind. Of course, we can and do make these, too, as our previous advertisements have shown, but it is UNUSUAL jobs which are meat and drink to us. With versatility as the keynote of our activities, the following list will prove that idle boasting is not one of our traits. These are not things we THINK we can do. They are just some of the jobs we have IN PROGRESS at present.

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Book Reviews

Electronic Measurements, by F. E. Terman, Sc.D., and J. M. Pettit, Ph.D. Publishers, the McGraw-Hill Publishing Co. Ltd., McGraw-Hill House, 95 Farringdon Street, London, E.C.4.

This book is publicized as a second edition to Professor Terman's very well-known earlier volume, *Measurements in Radio Engineering.* In point of fact, it is an entirely new book, as befits a subject which has made such great advances since 1935, when the original volume was written. As the authors point out in their preface, many of the measurements and techniques described in the new book were either completely non-existent or were merely laboratory curiosities at that time. The book aims at providing a "comprehensive engineering discussion of the measuring problems commonly encountered by radio or electronic engineers," and can be said to succeed remarkably well.

The chapters on radio frequency measurements have been brought up to date by inclusion of the techniques relating solely to ultra-high frequency and microwave work, and by the discussion of such things as standing-wave measurements at all frequencies, and the use of transmission-line charts. The material on amplifier measurements has been greatly increased in scope and now covers square-wave testing, measurement of transient response, and measurements on feedback amplifiers. Noise figure and its measurement is treated in some detail, as are modern methods of measuring harmonic and intermodulation distortion in audio amplifiers.

One of the most useful features of the original "Terman's Measurements" was the manner in which the author described the basic principles and functions of the more complex electronic measuring instruments. This part of the work was presented in such a way that the engineer reading it could, if necessary, set to and design standard or special items of test equipment for himself. Not the least important result of this approach is that the reader is made very well aware not only of the possibilities of the different measuring equipment, but also of its limitations. It is pleasing to note that the same principle has been followed by the authors of the new volume. Where equipment has to be built specially for certain types of work, this book will give the reader an excellent appreciation of just what he is up against, and of what order of accuracy he can expect from alternative methods, not to mention such eminently practical facts as the relative difficulties to be met and the speeds with which measurements may be taken by the different methods that may be available.

It should be emphasized that the book is first and foremost a practical one. Theoretical discussion is strictly limited to such as may be needed by the reader for an understanding of the various measurements described, as, too, are the mathematics, if such they can be called. No space is wasted on derivations, and all formulae included are those needed in the working out of results. As was the original volume in its day, this one is an exceedingly valuable compendium of all the measurements likely to be needed by radio or electronic engineers, whatever their particular phase of this now exceedingly wide subject. The writer of this review is only sorry that about 18 months ago he purchased a copy of the old "Measurements," which can now be expected to repose unused while "Electronic Measurements" becomes dog-eared with use.

The publishers have done their usual excellent job of production. The book, though large and heavy, can be expected to stand up to the large amount of use it will undoubtedly get, while the typography and diagrams are all that could be desired in clarity.

Principles of Radar, by J. F. Reintjes and G. T. Coate. Publishers, the McGraw-Hill Publishing Co. Ltd., 95 Farringdon Street, London, E.C.4.

This is the third edition of a book originally written by a number of staff members of the famous Massachusetts Institute of Technology, which did so much during the late war to bring America abreast of British radar development and then went on with original development and research work along parallel lines with the British. The first edition of this work was undertaken shortly after the institution at M.I.T. of the original Radar School in 1941, and was intended for use in the School. It was not until 1944 that it was first issued, as a classified document, to students at the school, and such was the speed of radar development at the time that a second edition was commenced immediately. The revision was not as complete as the original authors would have liked, because of the urgency of the job, so that the second edition, while containing the new material that was essential at the time, did not fulfil the authors' ideas of what the work should be. The present third edition represents a complete revision of the first two, both with respect to order of presentation and bringing the material up to date once more.

Containing almost 1000 pages, the book is concerned with the basic principles of pulse radar, and is intended

THE "TELECO"
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PICK-UP ARM
•
For a full technical description of this outstanding pick-up arm, please refer to the "Editor's Opinion," which will be found on page 38 of this issue.
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for those who are interested primarily in the basic concepts and techniques of radar. The authors assume that the reader has prior knowledge of the ordinary behaviour of valves, and of D.C. and A.C. theory, and a knowledge of mathematics up to and including simple differential and integral calculus. Even in the large number of pages available, it is clearly not possible for the authors to have treated any of the material in the great detail in which it is known by specialized workers in the many fields involved, but the matter is remarkably comprehensive, and leaves out nothing that a radio engineer, concerned for the first time with modern radar, should know of, at least in principle. The chapters deal with fundamental methods used in radar, timing circuits, modulators for radar transmitters, indicators, in their many manifestations, together with their circuitry, servomechanisms and data transmission systems, receivers and their circuits, transmission lines, antennas, waveguides, types of R.F. generators for the whole range of radar frequencies, and lastly with problems associated with radio propagation at these frequencies. As a comprehensive introduction to one of the latest branches of electronic application, the book could hardly be bettered, and we have no doubt that it will be a valuable addition to the literature.

When there's a better switch
ARCOLECTRIC will make it
New Zealand Agents
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ERRATA

With due apologies for any inconvenience that may have been caused readers, we must correct several errors that have taken place in recent circuit diagrams. The corrections are as follows:—

December, 1952:

"A General Purpose Pre-amplifier for Low-Level Pick-ups."—In the circuit diagram on page 5 of the above issue, the plate load resistor of the first EF40 stage is shown as 25k; this should be 250k.

February, 1953:

"A Wide-band Electronic Switch."—In this circuit, the screen resistors of V_1 and V_2 were inadvertently omitted. Each valve should have a screen resistor of 50k. These resistors are connected at one end to the screen pin of their respective valves, and the free ends are each connected to the ends of a 50k. potentiometer, the moving arm of which is in turn connected to H.T. The H.T. feed to the screens is then through the moving contact of the potentiometer, through each side of this to the upper ends of the screen resistors, and through the resistors to the screen pins.

March, 1953:

"A Linear Saw-tooth Generator Using Only Two Valves."—From the switch arm selecting the condensers labelled C_1, there should be connected a 100k. resistor in series with a 500k. variable resistor. The other end of this combination should be connected to the cathode of the ECC33. The variable resistor forms the fine frequency control.

"PANAMA" Electric Jugs

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Elegance of design and skilled craftsmanship have been combined to create this new release in the long line of quality

★ Constructed of heavy gauge chromium plated copper.

★ Fitted with plastic base and handle to provide maximum insulation against heat.

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NEW PRODUCTS

ULTIMATE RADIATOR SAFETY GUARD

The safety guard illustrated here is a new development constructed of steel and heavily electroplated. The guard has been produced in reply to requests that manufacturers of radiators produce something to prevent some of the disastrous accidents which have occurred by clothing being ignited by electric fires.

The "Ultimate" safety guard is easily clipped on any "Ultimate" EAA, EAB, 301, or 302 radiator and may be purchased as a separate item. "Ultimate" EAA and EAB radiators may be purchased with the usual type of guard or with this new safety guard if required. The manufacturers of "Ultimate" radiators suggest that all dealers keep a supply of these safety guards in stock because they are invaluable to the person who requires protection for kiddies and who desires to prevent accidental fires and nasty burns. The safety guard retails at 11s. 6d. and is available now.

A NEW APPRENTICESHIP ORDER FOR THE RADIO INDUSTRY

By N. SOUPER

A new Apprenticeship Order for the radio industry came into force on 1st April, 1953. The new Order differs from the old one in that it provides for apprentices in factories. There are now two classifications for apprentices, radio servicing and radio engineering.

The Electricians' Board, after receiving representations from the New Zealand Apprenticeship Committee, has decided to create a new form of registration for those apprentices in radio factories. In some instances, some factories that do not manufacture electrical equipment are not in a position to train apprentices to the same extent as retail establishments that do electrical repairs, such as toasters, irons, etc. I refer, of course, to the fitting of cords, plugs, etc. The Board has not as yet stated the class of registration that will be given to factory-trained apprentices. However, the actual classification does not matter for the moment.

The Electricians' Board has decided to act on the recommendation of the New Zealand Committee as to which class of registration an apprentice will be entitled. This applies only to radio engineering; radio servicing as applied to retail shops is similar to that existing at present.

Minimum age: 15 years.

Education: Two years' post-primary education and has reached a satisfactory standard in English and mathematics in a Fourth Form or higher.

Proportion: One apprentice to every two, or fraction of two radio servicemen employed—that is, in the radio servicing industry.

In the radio industry, the proportion of apprentices to journeymen shall not be more than one to every two, or fraction of two, radio tradesmen employed. For the purpose of this class, radio tradesmen shall mean the following: Tester, radio tester, technician, radio technician, designer, foreman, and in each case holding the appropriate registration under the Electricians Act, 1952 where work is carried out, or where instruction is given to an apprentice in work which requires registration under the Electricians Act, 1952.

Terms of apprenticeship: 10,000 hours.

Technical classes: (a) Where an apprentice resides or works within a convenient distance of a school which the New Zealand Committee is satisfied can during normal hours (working) provide instruction on a syllabus approved by that Committee, it may order such apprentice to attend during three years of his apprenticeship at such school for four continuous hours of instruction in each week, or alternatively, at the discretion of the New Zealand Committee, do eight hours of instruction in each fortnight.

I might add that the employers were strongly opposed to any form of daylight training, and, in spite of calling evidence before the Arbitration Court, the decision of the Court was against the employer. Mr. Hewitt, a

Proposed Course

OF

T.V.

LECTURE DEMONSTRATIONS

Those who can see the writing on the wall are wasting no time in getting "genned up" on *Television*. If YOU are wondering how you can do the same, against the day—not very far off now—when you will be working with TV receivers, either professionally or from amateur interest, you cannot afford to miss the announcement in last month's issue of *Radio and Electronics*, of the proposed course of lecture-demonstrations to be given by Mr. W. D. Foster, B.Sc., Editor of this journal. Briefly, the idea is a course of ten lectures, supplemented by demonstrations of actual television circuits in operation, and of picture-generating equipment. The fee is expected to be in the region of four guineas for the complete course, and fuller details will be found on page 47 of the issue of April, 1953. If you have not already done so, please cut out the form attached and send it to:

Radio and Electronics (N.Z.) Ltd.

P.O. BOX 8022, WELLINGTON

I am interested in and would be prepared to attend the proposed TV course to be held in Wellington.

Name .....

Address .....

.....

member of the Court, gave his written submissions in our favour.

There are many men at present employed in the radio engineering industry who have considerable technical knowledge and have been deprived of registration by the Electricians' Board on account of the fact that the Act did not provide for such a class of men. The Board has agreed that it will accept applications from these men provided it receives the recommendation of the New Zealand Apprenticeship Committee, and that after these men have passed a certain standard of examination approved by the Board and can produce evidence of time served in a factory, they will grant a certain minimum class of registration.

It is the duty now of all employers to advise such personnel who are in their employ of the position so that they can take the necessary steps to obtain registration. This is of vital importance to you, as such men can then be counted as radio tradesmen.

This is merely a brief outline of the conditions of the new Order, and members are strongly advised to consult the secretary of their local Employers' Association for further information before applying for permission to indenture a youth as an apprentice to the industry.

Abstract Service

(Continued from page 27.)

region of 100 Mc/s, the man-made noise is dominant, and little can be done at the receiver. Above 200 Mc/s, thermal noise is dominant, and here receiver design makes progress.

—Electronic Engineering (Eng.), Feb., 1953, p. 68.

TRANSMITTERS AND TRANSMITTING

The article deals with time division multiplex systems, and in particular pulse-amplitude modulated systems, which are attractive for areas not subjected to much injected noise. This form of modulation is useful for handling the many conversations passing through one switch. The circuitry for the system is given—multiplexing by stages, reduction of inter-channel crosstalk, and narrow-band T.D.M.

—Electronic Engineering (Eng.), Feb., 1953, p. 58.

Two of the more important trends in the development of short-wave communication systems during recent years have been (a) the increasing use of single-sideband method of operation, and (b) the provision of several telephony or telegraph channels by means of a single transmitter and receiver. The article outlines the s.s.b. working, states the advantages to be gained, and describes the basic techniques.

—The Post Office Electrical Engineers Journal (Eng.), Oct., 1952, p. 97.

TELEVISION

Apparatus is described which can combine a television signal with any other waveform to give the visual effect of the two signals simultaneously without the picture losing synchronism. This can be used to simulate the effect of various types of interference on television pictures. This is useful in estimating and investigating interference in transmission.

—Ibid., Jan., 1953, p. 172

The paper describes firstly the excessive redundancy in television signals, using the term in the sense of communication theory. The information in a picture is largely contained in the edges and boundaries, but in practice these occupy a very small part of the total area. The unequal probabilities of signal elements lying in boundaries and smooth surface regions is considered. Compression is shown to be possible by making such probabilities more nearly equal, using a system of recording.

Proceedings of the I.E.E. (Eng.), Part III, Jan., 1953, p. 9.

Labyrinth Baffler

(Continued from page 5.)

registers are likely to be horrid, owing to reflections inside the labyrinth affecting the acoustic impedance presented to the cone, in an entirely irregular and unpredictable manner.

When properly constructed, the labyrinth will be found to give a very smooth low-frequency performance, at least as good as can be had from a bass-reflex cabinet, and in some cases considerably better.

New TV Camera

(Continued from page 12.)

by step by pressing the handle forwards through the resilient stop and then swinging it backwards again).

The application of the hydraulic principle for operating the optical system offers many advantages:

1. Smooth and noiseless motion of all parts.
2. Great precision and little maintenance.
3. No interference will occur, disturbing the electronic part of the camera. Such interference is hard to prevent when an electric drive is employed.
4. Few restrictions are imposed on the external shape and dimensions of this hydraulic operating mechanism, and the electrical part of the camera is kept entirely separate so that the design of the latter is in no way restricted.

Address by Dr. C. D. Elyett

(Continued from page 14.)

star. Seventy areas have been found, and exploring further, we find there are as many invisible as visible stars. At Jodrell, near Manchester, an aerial system has been used for searching the galaxy of Andromeda. Noise from this nebula has been found and results indicate the earth's nebula and Andromeda's are twins.

Concluding, he said much of our progress in understanding the universe is due to the rapid wartime technological development.

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BINDERS FOR "R. & E."

These are available to hold 12 issues—price 5s. 6d.

NEW ZEALAND RADIO TRADERS' FEDERATION

As we go to press, news comes from the President of the New Zealand Radio Traders' Federation, Mr. N. Souper, that the annual conference of the Federation will be held in Christchurch on 19th and 20th May.

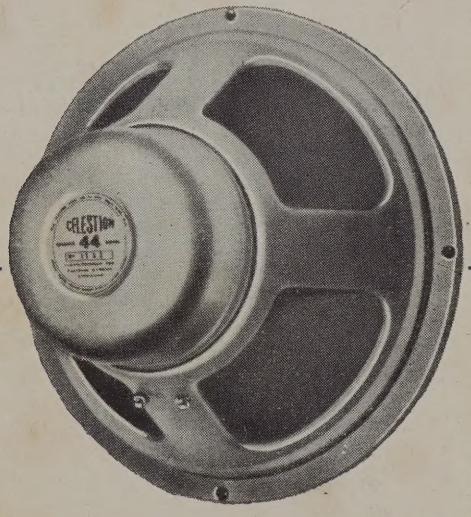
Arrangements are in the hands of the Canterbury Association, and delegates and guests may be sure of interesting entertainment to relieve the hard work the Executive has in store for all.

Important Announcement

WIDE RANGE OF

CELESTION

LOUDSPEAKERS
AGAIN AVAILABLE IN NEW ZEALAND



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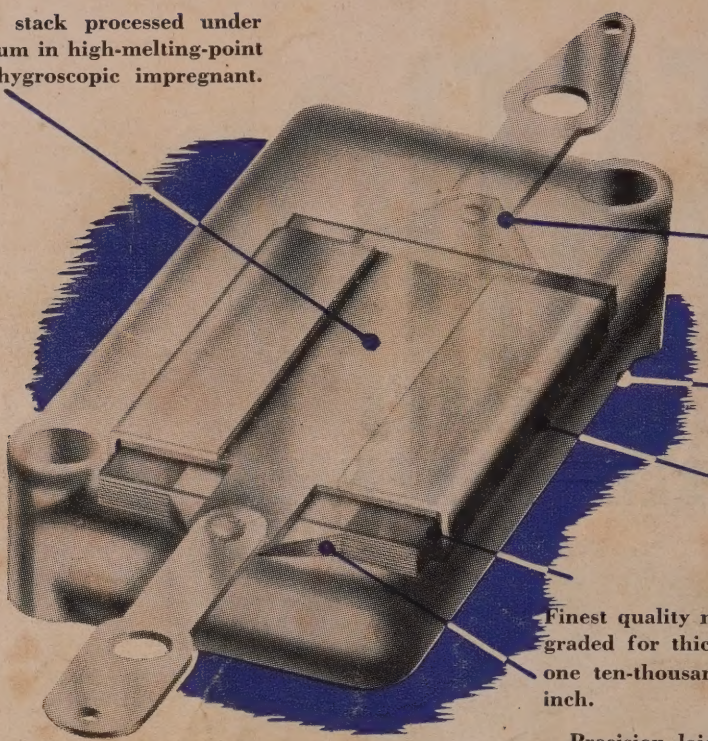

Hot tinned soldering tags, positively spot-welded to electrodes.

Moulding of high grade low-loss material.

Robust steel clamping plate to maintain stability.

Finest quality mica blades graded for thickness to one ten-thousandth of an inch.

Precision laid electrodes of heavy-gauge material providing ample current rating and mechanical strength.

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Temperature range — 40°C. to + 71°C.

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